# GENERAL QUALITY-ASSURANCE PROJECT PLAN FOR THE REMEDIAL INVESTIGATION OF THE NEW HAVEN PUBLIC-WATER-SUPPLY SITE, NEW HAVEN, MISSOURI

PREPARED FOR THE SUPERFUND DIVISION: U.S. ENVIRONMENTAL PROTECTION AGENCY REGION VII

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Contract No. **SSID 072X TO 00**

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*1.0 INTRODUCTION* ... *3*

**1.1 Purpose and Scope** ... **4**

**1.2 Project Background** ... **4**

**1.3 General Description of the Site** ... **5**
1.3.1 Physiographic setting ... 6
1.3.2 Geohydrology ... 6
1.3.3 Ground-water flow ... 7

**1.4 General Description of Operable Units** ... **8**
1.4.1 Riverfront Site (OU-1) ... 9
1.4.2 Kellwood Site (OU-2) ... 9
1.4.3 Old City Dump (OU-3) ... 10
1.4.4 East New Haven (OU-4) ... 10

*2.0 PROJECT MANAGEMENT* ... *10*

**2.1 Project Personnel and Training** ... **10**

**2.2 Quality Objectives and Criteria** ... **12**

**2.3 Quality Goals** ... **15**

**2.4 Documentation and Records** ... **15**

*3.0 MEASUREMENTS AND DATA ACQUISITION* ... *16*

**3.1 Sampling Protocols** ... **16**
3.1.1 Ground-water sampling protocol ... 16
3.1.1.1 Water-Level Measurements ... 16
3.1.1.2 Public- and Domestic-Supply Well Sampling ... 17
3.1.1.3 Monitoring Well Sampling ... 17
3.1.2 Surface-water sampling protocol ... 18
3.1.2.1 Discharge ... 18
3.1.2.2 Stream Sampling ... 19
3.1.2.3 Spring and Seep Sampling ... 20
3.1.3 Soil samples ... 20
3.1.3.1 Surficial Soil Sampling ... 20
3.1.3.2 Streambed-Sediment Sampling ... 21
3.1.4 Tree-core samples ... 21
3.1.5 Metal Detection and Underground Void Location Techniques ... 22

**3.2 Sample Handling and Custody** ... **23**
3.2.1 Compositing ... 26
3.2.2 Splitting ... 26
3.2.3 Sample Containers and Filtration ... 26
3.2.4 Sample Preservation ... 27
3.2.5 Sample Labeling and Shipping ... 27

**3.3 Field Equipment** ... **28**
3.3.1 Calibration of Field Instruments ... 28
3.3.1.1 Specific Conductance ... 28
3.3.1.2 pH ... 28
3.3.1.3 Dissolved Oxygen ... 29
3.3.1.4 Portable Gas Chromatograph ... 29
3.3.2 Equipment Decontamination ... 29
3.3.3 Sampling Containers and Supplies ... 30

**3.4 Analytical Methods** ... **30**
3.4.1 General Description of Analytical Methods ... 30

3.4.1.1 Volatile Organic Compounds in Water, Soil, and Sediment ........ 30
3.4.1.2 Toxicity Characteristic Leaching Procedure for VOCs in Soil and Sediment ........ 31
3.4.1.3 Semivolatile Organic Compounds in Soil and Sediment ........ 31
3.4.1.4 Organochlorine Pesticides and PCBs in Soil and Sediment ........ 31
3.4.1.5 Grain Size and Major and Trace Elements in Soil and Sediments ........ 32
3.4.1.6 Physical Properties ........ 32
3.4.1.7 Nutrients and Anions in Water ........ 32
3.4.1.8 Major and Trace Cations in Water ........ 33
3.4.2 Method Reporting Levels ........ 33
3.4.3 Calibration ........ 34

**3.5 Quality Control Checks for Field and Laboratory Operations ........ 35**
3.5.1 Field Quality Checks ........ 35
3.5.2 Laboratory Quality Checks ........ 37
3.5.2.1 USGS Branch of Quality Systems ........ 37
3.5.2.2 National-Water Quality Laboratory ........ 38
3.5.2.3 Quality Water Services Unit ........ 38
3.5.2.4 U.S. Geological Survey Contract Laboratory ........ 38

***4.0 DATA MANAGEMENT ........ 39***

**4.1 Data Reduction and Verification ........ 40**

**4.2 Data Documentation ........ 40**

***5.0 SELECTED REFERENCES ........ 41***

# 1.0 INTRODUCTION

This general Quality-Assurance Project Plan (QAPP) describes the methods and procedures that will be used by the U.S. Geological Survey (USGS) at the Riverfront site in New Haven, Missouri, to ensure that appropriate levels of quality assurance (QA) and quality control (QC) are achieved. The QAPP will serve to ensure the quality, precision, accuracy, and completeness of data generated during the Remedial Investigation/Feasibility Study (RI/FS) of four Operable Units (OUs) at the New Haven Public-Water-Supply Site. The RI/FS is being conducted by the U.S. Environmental Protection Agency (USEPA) Region VII under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA and Superfund). The USGS is the principle investigator and is responsible for conducting all RI tasks excluding the Risk Assessment (RA) and treatability studies (if needed) under interagency agreement DW 1495217301-0. The Missouri Department of Health (MDOH) is responsible for conducting the RA for the USEPA, and a USEPA Response Action Contractor (RAC) is responsible for conducting the FS. The overall RI/FS coordinator is Ms. Shelley Brodie, USEPA Region VII Remedial Project Manager (RPM).

The QAPP outlines the organization, objectives, and QA/QC activities to achieve the desired data quality goals and was prepared in accordance with guidance from the USEPA and the work plan for RI work at New Haven. All work will be performed under the requirements stated in <u>Work Plan for the Remedial Investigation of the New Haven Public-Water-Supply Site, New Haven, Missouri</u>.

## 1.1 Purpose and Scope

Since 1986, it has been known that two public-water-supply wells in the city of New Haven (wells W1 and W2) have been contaminated by the chlorinated solvent tetrachloroethene (PCE). This solvent has been found at the Riverfront site and several other locations in New Haven. The purpose of this QAPP is to ensure that data collected are of adequate quality for the completion of the RI and RI report. The QAPP describes the project background, describes the environmental setting, identifies the potential contaminants of concern, states the quality-assurance goals, describes the sampling and analytical methods to be used, and describes the general quality checks and data management protocols used by the USGS. The ultimate goal of the USGS is to provide the highest quality information on the quantity and quality of the Nation's water resources. An extensive QA program has been implemented to ensure the production of scientifically sound, legally defensible data of known and documented quality.

## 1.2 Project Background

There are five deep, high-production wells in New Haven (fig. 1): four city wells (W1, W2, W3, W4) and one well owned by a local bottling company (hereinafter referred to as the Pepsi well[1]). During 1986 the Missouri Department of Natural Resources (MDNR) began testing public-water-supply wells for volatile organic compounds (VOCs) and detected the chlorinated solvent PCE in city wells W1 and W2 (Missouri Department of Natural Resources, 1988). Concentrations of PCE in water samples from well W2 increased steadily with time from the initial detection of 28 μg/L (micrograms per liter) to a maximum of 140 μg/L before the well was removed from service in 1993. The concentrations of PCE in water samples from well W1 generally were less than the maximum allowable contamination level of 5 μg/L; however, well W1 is in the Missouri River flood plain and had a prior history of bacterial contamination attributed to a poor surface casing seal that resulted in the removal of well W1 from service in 1989. During 1988 and early 1993, two additional city wells (wells W3 and W4) were installed in the southern part of the city (fig. 1) to compensate for the loss of wells W1 and W2. To date, subsequent sampling by various agencies has not detected VOCs in city wells W3 or W4, or in the Pepsi well.

Results of various investigations of the Riverfront site RI[2] by the MDNR and the USEPA have identified at least four potential sources of chlorinated solvents in New Haven (fig. 2):

1. The Riverfront site – the location of an old manufacturing facility in downtown New Haven where solvents were used and disposed of on-site

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[1] Use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

[2] The entire USEPA RI project in New Haven, MO is titled ‘The Riverfront Site’. However, within this site are four operable units (OUs), one of which is the Riverfront site, which is located in the downtown business district. For the rest of this QA plan, any reference to the Riverfront site will mean to the OU site, unless ‘RI’ is stated with the location.

2. The Kellwood site – a manufacturing facility where solvents were disposed of on-site

3. The old city dump – disposal area for large quantities of various industrial wastes and household waste

4. The old dry cleaners

Subsurface soil sampling conducted by the MDNR and USEPA detected large concentrations of PCE in soil samples from the Riverfront site and the Kellwood site [thousands of mg/kg (milligrams per kilogram)] and the old city dump (less than 1 mg/kg). No soil sampling has been done at the old dry cleaners; however, tree core samples from the site did not contain PCE, whereas tree core samples from the Riverfront site and the old city dump did. In addition to the soil contamination at the Riverfront site, results from an Expanded Site Investigation-Remedial Investigation (ESI-RI) indicate that large concentrations of PCE (less than 0.1 to 199 μg/L), TCE (trichloroethene; less than 0.1 to 48.8 μg/L), cis-DCE (cis-1,2-dichloroethene; less than 0.1 to 246 μg/L), and VC (vinyl chloride; less than 0.2 to 17.1 μg/L) are in the alluvial aquifer that is beneath it.

The Riverfront site and the old dry cleaners are within 700 ft (feet) of the two contaminated city wells (W1 and W2), with the Kellwood site approximately 1.25 mi (miles) south (but less than 700 ft from city well W3) and the old city dump approximately 1.5 mi southeast (fig. 2). In addition to these areas, PCE has been detected in a stream about 1,500 ft south of the Riverfront site, and a recent (July 2000) confidential interview with a resident indicated that PCE was disposed of in the city sanitary sewer system, and possibly on the land surface, at a residence about 0.5 mi southwest of city well W2.

Because of the uncertainty in the direction of ground-water flow, and the detection of PCE in soils at several sites scattered across New Haven, the source of the contamination in city wells W1 and W2 has not been attributed to any one particular source. The potential for continued and additional human exposure to the contaminant PCE has warranted the Riverfront site RI be placed on the National Priorities List (NPL) to receive USEPA Superfund assistance. This placement on the NPL is attributed to the multiple potential sources (some known and some unknown) of PCE contamination to the ground water at New Haven, the presence of large PCE concentrations in the soil at the Riverfront site and in the shallow ground water at the Kellwood site, and the proximity of the Kellwood site to city well W3 and several domestic wells.

### 1.3 General Description of the Site

The city of New Haven (population about 1,600) is located along the southern bank of the Missouri River in Franklin County, about 50 mi west of St. Louis, Missouri (fig. 1). The city is similar in character to other small towns and cities along the Missouri River, with historic late 1800's era homes built along the steep river valley slopes overlooking a downtown business district adjacent to the river. The downtown business district is located within a narrow (less than 600 ft wide) strip of flood plain and consists of several small shops and restaurants, a few homes, and several small old manufacturing facilities. This area is surrounded by a flood protection levee, which is maintained by the United States Army Corp of Engineers. The principle road in New Haven is State Highway 100, which runs along part of an east-west trending ridge about 1 mi south of the Missouri River. The ridge forms a topographic divide between the Missouri River valley to the north and the Boeuf Creek valley to the south (fig. 2). An industrial park (developed in the mid-1970s) containing several large manufacturing facilities, one of which is the Kellwood Company, is located south of this ridge and State Highway 100 (fig. 2). Land use north of the highway, including the downtown area, is mostly residential, and land use outside the city is mostly pasture with some row crops. Average annual precipitation is about 37 in. (U.S. Department of Commerce, 1990).

### 1.3.1 Physiographic setting

New Haven is located along the northern boundary of the Salem Plateau physiographic subprovince of the Ozark Plateau (Fenneman, 1938). The Salem Plateau is characterized by a moderate to rugged terrain of thin soils and narrow steep-walled valleys (Imes and others, 1996). Topographic relief is the result of gradual uplift of the Ozark dome in southern Missouri and erosion of the uplifted rocks by precipitation runoff and stream flow (Imes and others, 1996). The relief in the New Haven area is accentuated because of proximity to the Missouri River, which controls the base level for most streams in western and central Missouri. Land surface altitude ranges from a low of 470 ft above sea level at the Missouri River to about 920 ft on a ridge about 3 mi west of the city. In the upland areas of New Haven, loess deposits as much as 15 ft thick overlie the cherty, silty, clay residuum that is characteristic of surficial materials throughout most of the Salem Plateau (Mosby, 1988).

### 1.3.2 Geohydrology

There are two primary aquifers in the New Haven area, the Missouri River alluvial aquifer and the bedrock Ozark aquifer. The Missouri River alluvium is composed of silty-clay or clay near the land surface grading downward into coarser-grained sand and gravel near the base. Typically the silt and clay zone is less than 20 ft thick. Using seismic sounding, Emmett and Jeffery (1968) calculated the maximum thickness of the alluvium at about 105 ft near the center of the valley (about 1 mi north of the Riverfront site). However, beneath the Riverfront site the alluvium is about 30 ft thick. The saturated, coarser-grained sediments of the alluvium are a highly productive alluvial aquifer that is used in Missouri for domestic, industrial, and public supply. Specific capacity values of about 65 gallon per ft have been calculated for the more productive areas of this alluvial aquifer (Emmett and Jeffery, 1968). In the immediate vicinity of New Haven, however, the alluvial aquifer is unused.

Bedrock units beneath New Haven are part of the Ozark aquifer. The Ozark aquifer is a thick sequence of water-bearing dolostone, limestone, and sandstone formations ranging in age from Late Cambrian to Middle Devonian (Imes and Emmett, 1994). Although these formations collectively act as a regional aquifer, the water-yielding capacity of the individual formations is variable. Geologic logs from New Haven city wells W1 and W2 and the Pepsi well indicate that the uppermost bedrock units beneath New Haven are the Ordovician age Cotter Dolomite and Jefferson City Dolomite (fig. 3). The thickness of the Cotter Dolomite in the New Haven area varies substantially (87 to 230 ft) because the formation has been partially eroded. The Cotter and Jefferson City Dolomites contain numerous thin shale and mudstone partings and are less permeable than the underlying formations of the Ozark aquifer (Imes and Emmett, 1994). Most domestic wells completed in the New Haven area are open to the Jefferson City Dolomite or the top of the underlying Roubidoux Formation.

Beneath the Cotter and Jefferson City Dolomites, geologic formations in the Ozark aquifer are, in order of increasing age, the Roubidoux Formation, Gasconade Dolomite, Gunter Sandstone Member of the Gasconade Dolomite, Eminence Dolomite, and Potosi Dolomite. The Roubidoux Formation probably is the most widely used formation in the Salem Plateau for domestic supply (Miller and Vandike, 1997). The lithology of the Roubidoux Formation is highly variable and includes sandstone, sandy dolomite, dolostone, mudstone, chert, and cherty dolostone (Thompson, 1991). Although yields from domestic wells open to the Roubidoux Formation average between 15 and 35 gpm (gallons per minute), in areas such as New Haven where the formation is buried several hundred feet, well yields typically are larger (Miller and Vandike, 1997). The Roubidoux Formation beneath New Haven is about 115 ft thick. The deeper units, especially the Gunter Sandstone Member of the Gasconade Dolomite and the Potosi Dolomite are target units for high-capacity municipal and industrial wells. Wells open to the Gunter Sandstone Member typically yield 40 to 50 gpm; however, yields from production wells open to this unit just east of New Haven can be as large as several hundred gpm (Miller and Vandike, 1997). New Haven city wells W1, W2 and W4, and the Pepsi well were drilled into the Potosi Dolomite. The Potosi Dolomite is the lowermost geologic unit in the Ozark aquifer and yields of 200 to 1,000 gpm are not unusual from wells open to this unit. The high yields are thought to be the result of interconnected vugs and solution channels within the formation (Imes and Emmett, 1994). City well W3 was originally drilled into the Potosi Dolomite but because of turbidity problems, the lower pat of the well bore was plugged leaving the well open to the Gasconade and Eminence Dolomites. Although not as productive as the underlying Potosi Dolomite, yields from wells open to the Eminence Dolomite range from 75 to 250 gpm (Miller and Vandike, 1997).

### 1.3.3 Ground-water flow

Ground-water in the Missouri River alluvial aquifer comes from infiltration of precipitation, overbank flooding or sustained high river stages, and a relatively small amount from discharge of underlying bedrock aquifers (Emmett and Jeffery, 1968). Water in the alluvial aquifer generally is unconfined, but during wet seasons, the silty-clay cap that extends across much of the floodplain may marginally confine it. The main ground-water discharge occurs by seepage from the alluvium into the river during low river stages. During high river stages, flow is reversed and water from the river recharges the alluvium. Under most conditions, flow in the alluvial aquifer is generally towards the river channel and downstream. Water levels from USGS installed alluvial monitoring wells and a privately owned hand-dug well measured during the ESI-RI indicate that during non-flood stage conditions, the direction of flow in the alluvium at the Riverfront site is to the northeast. Ground water in the Ozark aquifer is unconfined throughout the Salem Plateau and ground-water flow directions are strongly influenced by regional topography (Imes and Emmett, 1994). Ground-water movement generally is from upland areas between major rivers and streams towards valleys where it discharges as base-flow to the streams. The Missouri River and associated alluvial aquifer are regional ground-water discharge areas. Regional ground-water flow within the Ozark aquifer generally is from upland areas more than 60 miles south of New Haven northward towards the Missouri River. Superimposed upon the regional flow system are local, generally shallow, flow systems influenced by local topography. Two separate ground-water flow systems (shallow and deep) probably exist within the Ozark aquifer in the New Haven area. Based on the available data, the boundary between shallow and deep flow systems cannot be determined, but it probably occurs below the Roubidoux Formation. Most domestic wells in the New Haven area are about 400 ft deep, are drilled into the lower part of the Jefferson City Dolomite or upper part of the Roubidoux Formation, and, therefore, are open to the shallow flow system. The city and Pepsi wells are much deeper (more than 800 ft deep), have deeper casing, and probably are open predominantly to the deep flow system. City wells W1 and W2 have relatively shallow casing depths (less than 220 ft) and probably are open to both the shallow and deep flow systems.

### 1.4 General Description of Operable Units

Several areas of known PCE contamination in soils or ground water exist within New Haven; however, none of these sources have been unequivocally linked to the PCE contamination detected in city wells W1 and W2. Because the successful remediation of ground-water contamination depends upon determining the contaminant source, a significant part of the RI effort is directed towards determining the source(s) of PCE contamination. The work plan was segregated into four separate OUs to more clearly identify the specific DQOs (Data Quality Objectives) in each proposed area of investigation and facilitate the management of field tasks. This approach is essential given the widely scattered nature of the sites, unknown mechanism of transport into the closed city wells, and unknown source and extent of ground-water contamination in New Haven. The four OUs that have been identified for the Riverfront site RI are (fig. 2): (1) the Riverfront site in downtown New Haven, OU-1; (2) the Kellwood site on Industrial Drive in southern New Haven, OU-2; (3) the old city dump in eastern New Haven, OU-3; and (4) the undeveloped area south and east of monitoring well BW-02, hereinafter referred to as East New Haven, OU-4. OU-1, OU-2, and OU-3 were designated because they are geographically disconnected, have different histories of industrial use and waste disposal activities, and potentially have different potential receptors and contaminant migration paths. OU-4 (East New Haven) was designated because of an apparent unidentified PCE source up-gradient of city well W2 and monitoring well BW-02. A summary of the OUs is given in table 1.

**Table 1**. Summary of Operable Units designated for the Remedial Investigation.
[PCE, tetrachloroethene; MDOH, Missouri Department of Health; TCE, trichloroethene; VC, vinyl chloride; MCL, maximum contaminant level; ft, feet; mg/kg, milligram per kilogram

| Operable Unit Number | Name | Approximate area of investigation | Contamination summary |
|---|---|---|---|
| 1 | Riverfront site | 2 acres | - Known PCE in soils above MDOH guidelines<br>- PCE, TCE, VC above MCL in ground water<br>- Proximity to contaminated city wells W1 and W2 (600 ft) |
| 2 | Kellwood site | 20 acres (primary site is about 7 acres) | - Previously contaminated soils remediated to less than 1 mg/kg PCE<br>- PCE above MCL in shallow ground water<br>- PCE in nearby domestic well<br>- Proximity to city well W3 (700 ft) |

| | | | |
|---|---|---|---|
| 3 | Old city dump | 3 acres | - Trace levels of PCE in soils and ground water<br>- History of heavy use by various industries |
| 4 | East New Haven | 300 acres | - Unknown PCE source or extent<br>- PCE above MCL in bedrock and surface water<br>- Up-gradient of city well W2.<br>- Possible PCE dumping in nearby sanitary sewer |

### 1.4.1 Riverfront Site (OU-1)

The Riverfront site is located on the northeast corner of the intersection of Front Street and Cottonwood Street in downtown New Haven (fig. 4). During September 1987, the MDNR conducted a PA (Preliminary Assessment) of what was then called the New Haven Public Water Supply Site. Interviews with employees from area industries indicated several potential sources of the PCE detected in city wells W1 and W2, including the Riverfront site. Various industries have operated at the site since the 1950s, including metal fabrication, furniture assembly and painting, metal tempering, and automotive repair. Given the types of industrial uses at the facility, the types of waste expected include scrap metal and metal shavings (aluminum and steel), chlorinated solvents (used to degrease metals), paints and paint solvents, and hydrocarbons (fuels and oils). During 1988 and 1989, the MDNR collected a total of three soil samples from the Riverfront site (Missouri department of Natural Resources, 1988 and 1989). Results of the sampling detected PCE in all three soil samples. PCE also was found in tree core samples and water samples collected during 1999 by the USGS from a hand-dug well immediately north of the Riverfront site, from three alluvial monitoring wells (TW-B, TW-C, and TW-D) installed at or adjacent to the Riverfront site, and from two bedrock monitoring wells (BW-01 and BW-01A) located between the Riverfront site and city well W2. The volumes of hazardous materials used and disposed at the facility are unknown, and the volume of contaminated media (soils and ground water) is only approximate.

### 1.4.2 Kellwood Site (OU-2)

The Kellwood site is located at 202 Industrial Drive in southern New Haven. The site consists of an industrial building currently owned by Metalcraft Inc. and a 1-acre vacant lot owned by the city of New Haven immediately north of the Metalcraft building (fig. 5). The Kellwood site also was identified as a potential source of PCE contamination to city wells W1 and W2 during the PA conducted by MDNR in 1987. Interviews with current and former employees indicated that during 1972, metal operations formerly housed at the Riverfront site were moved to a new facility on Industrial Drive (Kellwood site) and that the facility used PCE (Singleton, 1987; Mosby, 1988; Bobbit, 1992). Five-gallon buckets of waste PCE were routinely dumped on the north side of the site between 1972 and about 1984 (Struckhoff, 1989). Interviews indicate that the practice of disposing waste solvent on the ground north of the building ceased when PCE was detected in the city wells by the MDNR (Bobbit, 1992). Large concentrations of PCE and TCE were detected in a composite soil sample collected along the north side of the Metalcraft building (Missouri Department of Natural Resources, 1989). During 1994, the Kellwood Company and MDNR entered into a voluntary cleanup agreement for remediation of PCE- and TCE-contaminated soils at the site, with the cleanup goal for soils at the site set at 1 mg/kg. In 1999 the cleanup goal for soils was met, but small concentrations of PCE continue to be detected in water samples collected from a French drain system that was installed as part of the cleanup process. PCE also has been detected in water samples collected from monitoring wells and a domestic well southwest of the Kellwood site.

#### 1.4.3 Old City Dump (OU-3)

The 1.5-acre old city dump located on the eastern side of New Haven was used as a community dump for domestic and industrial wastes from the mid-1950s to 1972 when the dump was closed (fig. 2). An inspection of the site during September 1989 indicated the presence of paint wastes and dozens of old drums. Interviews with a number of citizens indicated that hundreds of drums of industrial wastes from the Kellwood Fabrics Division were disposed of in the dump. Interviews also indicate that liquid contents of the drums were burned in a pit and that the smoke from the fire could be seen for miles. Because the dump is located more than 1 mile southeast of city wells W1 and W2, the MDNR did not consider the dump a likely source of PCE contamination in the city wells and no further investigations were done at the site. The USGS found a small concentration of PCE in a tree core sample from the east side of the dump and a trace amount of PCE in a sample from a seep on the north side of the dump.

#### 1.4.4 East New Haven (OU-4)

The 250-acre east New Haven area encompasses the area bounded on the north by Orchard Street, on the west by Miller Street, on the south by State Highway 100, and on the east by the 200 tributary (figs.2 and 6). The area is mostly overgrown pasture with thick woods on steep slopes. A reconnaissance and preliminary investigation of the area was initiated after the detection of large (more than 300 µg/L) PCE concentrations during the drilling of bedrock monitoring well BW-02. Monitoring well BW-02 was intended to be an up-gradient monitoring well from the Riverfront site and city well W2, and PCE was not expected to be found. The detection of PCE within the bedrock strongly indicates a PCE contamination source further up-gradient to the south. Because of the detection of PCE in monitoring well BW-02, a reconnaissance of seeps, springs, and streams was conducted in the area south of BW-02. Results of this reconnaissance indicate the presence of PCE in a tributary (210 tributary) that flows northeastward from Miller Street (fig. 6). The detection of PCE in bedrock monitoring well BW-02 and the 210 tributary indicate the disposal of PCE-containing wastes in this area. The location and quantity of the waste is unknown.

# 2.0 PROJECT MANAGEMENT

## 2.1 Project Personnel and Training

Shelley Brodie, the USEPA RPM, will coordinate the RI/FS. The USGS is responsible for conducting field activities, ensuring data quality, and preparation of the RI document. The primary USGS personnel working on the RI include John Schumacher, project chief (GS-12, full time); Jack Friesner, project hydrologist (GS-9, full time); Jerri Davis, project QA officer (GS-12, part-time); Jeffery Imes, supervisory hydrologist (GS-12, part time), and various hydrologic technicians. Responsibilities of key USGS personnel involved with the project are summarized in table 2.

**Table 2**. Responsibilities of USGS project staff

| | | |
|---|---|---|
| Jim Barks | USGS District Chief | Responsible for all USGS-WRD activities in Missouri and responsible for ensuring USGS policy is followed and USGS obligations are met. |
| Jeffery Imes | USGS Ground-water Section Chief | Responsible for overall project budgets and personnel resources; primary reviewer of technical interpretations. |
| John Schumacher | USGS RI Project Manager | Responsible for project planning, coordination, and ensuring project deadlines and deliverables are met. Also responsible for overseeing field investigation activities and ensuring FSP activities are followed and project is completed within budget. Duties also include preparation of contract specifications and oversight of subcontracts. Also responsible for preparing quarterly narrative progress reports and project GIS database. |
| John Schumacher | USGS Health and Safety Officer | Responsible for ensuring those provisions in the health and safety plan are implemented in the field. Changing field conditions require decisions to be made concerning work practices and protective equipment. |
| Pam Keeney | USGS Administrative Officer | USGS administrative officer responsible for financial management of MOU between USGS and USEPA, addressing USEPA audits, and oversight of all subcontracts. |
| Jerri Davis | USGS RI Quality-Assurance Officer | Responsible for ensuring appropriate data collection protocols are followed, properly documented, and QA/QC procedures are followed and suitable to meet project DQOs. Also responsible for project database. |
| Jack Friesner | Field-Work Team Leader | Field team leader and responsible for conducting field activities and following FSP or documenting and reporting deviations to the project manager. |

| | | |
|---|---|---|
| Paul Brenden | Hydrologic Technician | Assists in the collection of field data, sample shipment, and sample management. |
| Stephanie Klein | Field Sampler | Assists in the collection of field data, sample shipment, and sample management. |

All USGS personnel working on the project are trained in the collection of ground- and surface-water, soil, streambed-sediment, and tree core samples and will participate in the USGS National Field Quality-Assurance (NFQA) program. This program provides annual blind samples to all personnel performing field water-quality measurements. The program monitors the ability to accurately measure specific conductance, pH, and alkalinity. In addition, all personnel will have completed the basic 40-hour health and safety training course "Hazardous Waste Operations and Emergency Response" (HAZWOPER) and annual 8-hour refresher courses. A yearly medical exam is also required for field personnel.

## 2.2 Quality Objectives and Criteria

The quality objective of the project is to provide valid data of known and documented quality from ground water (alluvial and bedrock wells), surface water (Missouri River and small tributaries), seeps, springs, soils, streambed sediments, and tree cores in the New Haven area. Standardized field screening methods or published USEPA or USGS analytical methods will be used during this study. Sample representativeness and comparability will be addressed by collecting samples according to established USGS sampling protocols referenced in this document. The USGS collects tens of thousands of water-quality samples from across the United States under strict data collection protocols. Strict adherence or documentation of variation from these protocols provides samples that accurately represent the water quality during the time of collection.

The QA objectives for all measurements are stated in terms of precision, accuracy, representativeness, completeness, and comparability (PARCC parameters):

<u>Precision</u>—The degree to which the measurement is reproducible. Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the stand deviation.

Precision of field measurements will be evaluated by:

(a) Duplicate measurements of hydrologic properties, such as stream discharge, pH, temperature, specific conductance, dissolved oxygen (DO), and alkalinity.

(b) Laboratory analysis of duplicate samples in the case of field screens for VOCs.

Precision of laboratory analytical data will be evaluated by:

(a) Duplicate laboratory control samples.

(b) Matrix spikes and matrix spike duplicates.

(c) Duplicate samples—Agreement between duplicate analyses of environmental samples generally shall be within 20 to 40 percent relative percent difference (RPD).

Accuracy—The degree of agreement of a measurement with an accepted reference or true value, usually expressed as the difference between the two values, or the difference as a percentage of the reference or true value. Accuracy is a measure of the bias in a system.

Accuracy of field measurements will be evaluated by:

(a) Standard methods—Methods of analysis shall be used which, whenever possible, are recognized and considered as standard by the scientific community.

(b) Instrument calibrations—Calibration and calibration checks of field instruments and equipment shall be performed at a frequency that will ensure each measurement is accurate.

(c) QA field standards—All USGS personnel involved in the collection of water-quality samples are required to participate in the annual USGS NFQA program (section 2.1).

Accuracy of laboratory analytical data will be evaluated by:

(a) Standard methods—Methods of analysis shall be used which, whenever possible, are recognized and considered as standard by the scientific community.

(b) Calibration standards—Primary standards shall be obtained from the National Institute of Standards and Technology (NIST, formerly the National Bureau of Standards), USEPA repository, or other reliable commercial sources.

(c) Performance evaluation studies—Laboratory performance on performance evaluation samples must be such that certification is maintained.

(d) Method blanks—Results must fall within laboratory established control limits.

(e) Duplicate laboratory control samples —Results must fall within laboratory established control limits.

(f) Matrix spikes and matrix spike duplicates—The percent recovery for each analyte should be within acceptable limits.

(g) Surrogate spikes—Results must fall within laboratory established control limits.

The determination of the accuracy of a measurement requires knowledge of the true or accepted value for the signal being measured. Accuracy may be calculated in terms of percent recovery as follows:

$$\text{Percent Recovery} = (X/T) \times 100$$

where: $X$ = the observed value of measurement, and

$T$ = “true” value

Representativeness—The degree to which data accurately and precisely represent a characteristic of a population, parameter variation at a sampling point, a process condition, or an environmental condition.

Representativeness of field data will be evaluated by the following:

(a) Use of standard methods of measurement and sample collection.

(b) Documentation of reasons for use of nonstandard techniques.

(c) Adherence to chain-of-custody procedures.

Representativeness of laboratory analytical data will be evaluated by:

(a) Use of preservation techniques (such as chilling or acidification before and during shipment) to minimize sample degradation, which may occur between sample collection and sample analysis.

(b) Prescribed holding times shall be adhered to by the analytical laboratory.

(c) Equipment, field, trip, and laboratory blank analyses will be used to determine if samples have been contaminated.

(d) Matrix spikes and surrogate spikes will be used to determine the presence of matrix effects.

<u>Completeness</u>—A measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under normal conditions.

Completeness of field data will be evaluated by the following methods:

(a) All measurements and observations shall be recorded on a standardized USGS water-quality field notes form or in a field notebook.

(b) All deviations from standard operating procedure shall be recorded and documented on the field notes form.

Completeness of laboratory analytical data will be evaluated by the following methods:

(a) Each data set (batch) shall contain all QC check analyses verifying precision and accuracy for the analytical protocol.

(b) Each data set (batch) shall contain all equipment, field, and trip blank analyses.

(c) All pertinent dates shall be recorded (for example, date received, extracted, and analyzed).

(d) All requested analyses shall be performed or documentation provided as to the reason for nonperformance.

<u>Comparability</u>—Expresses the confidence with which one data set can be compared to another data set measuring the same property.

Comparability of field measurements will be evaluated by:

(a) Standard methods—Methods of measurement shall be used which, whenever possible, are recognized and considered as standard by the scientific community.

(b) Reporting units—Data shall be consistently reported in units consistent with laboratory methods.

Comparability of laboratory analytical data will be evaluated by:

(a) Standard methods—Methods of measurement shall be used which, whenever possible, are recognized and considered as standard by the scientific community. In general, USEPA methods are used except when lower detection levels are required, then USGS methods are used.

Reporting units—data shall be consistently reported in units consistent with laboratory methods.

## 2.3 Quality Goals

The numerical QA goals for field and laboratory measured data are listed in table 3. Failure to achieve these criteria generally will result in resampling and analysis.

**Table 3**. Numerical quality-assurance goals

| Constituent | Accuracy | Precision |
|---|---|---|
| Water level | +/- 0.01 feet | Within 5 percent |
| Water temperature | +/- 0.5 degrees Celsius | Within 10 percent |
| Specific conductance | +/- 2 percent | Within 5 percent |
| Dissolved oxygen | +/- 0.5 mg/L | Within 10 percent |
| pH | +/- 0.05 pH unit | Within 10 percent |
| Alkalinity | +/- 5 percent | Within 10 percent |
| Portable gas chromatograph | +/- 30 percent | Generally within 30 percent |
| Laboratory analytes | +/- 3 standard deviations | Generally within 20 percent |

A minimum completeness goal of 80 percent for soils and sediments and 90 percent for ground water and surface water is required for this project. The critical samples to meet the project objectives are those collected from public-water-supply, domestic, and temporary monitoring wells, streams, springs, seeps, soils, streambed sediments, and tree cores.

## 2.4 Documentation and Records

USGS personnel will record all pertinent field activities associated with the installation of boreholes and monitoring wells, level surveys, and the collection of water, soil, soil-gas, streambed-sediment, and tree-core samples in a field notebook. Each sample location will be assigned a 15-digit number comprised of latitude and longitude, plus a 2-digit sequence number. Detailed documentation of water samples collected from wells, streams, springs, or seeps, sample-collection method, and variation from standard protocols (if needed) will be made on a USGS water-quality field notes form.

# 3.0 MEASUREMENTS AND DATA ACQUISITION

## 3.1 Sampling Protocols

Standardized USGS sampling procedures will be followed for collection of all samples. Procedures may be varied because of circumstances encountered in the field; however, variations from established procedures will be carefully documented. Protective and non-contaminating gloves, such as powder-free latex or polyethylene, will be worn during all sampling phases (including soil and water sample collection, water-level measurements, well purging, and so forth) as well as during decontamination procedures. Gloves will be changed between sampling sites, and a clean hands-dirty hands protocol will be followed. Generally, one person is responsible for handling all of the sample collection equipment (dirty hands); this person will not have any contact with the sample to be collected or processed. A second person is responsible for compositing samples, completing field chemical measurements, and processing the sample (clean hands).

### 3.1.1 Ground-water sampling protocol

Concentrations of many trace elements and organic constituents in ground water range in the low microgram per liter range or smaller. The goal of USGS water-sampling procedures is to provide a standard and consistent protocol applicable to the collection of ground-water samples with analyte concentrations in the low to sub-microgram per liter range. General guidelines for the collection of ground-water samples are presented in this section. Ground-water samples generally will be collected according to established USGS procedures and those described in the following publications: Bradford (1985), Brown and others (1970), Koterba and others (1995), Lapham and others (1996), Wilde and others (1998a and 1999a), Wood (1976), and various USGS Technical Memoranda. Because of the multitude of situations encountered in the field, the guidelines described below will not cover all circumstances, and unique situations may require deviation from standard methodologies. In these cases, the best judgment of field personnel will be used and sample collection will be fully documented.

#### 3.1.1.1 Water-Level Measurements

Static water-level measurements will be made before sampling any public-supply, domestic, or monitoring well. Water levels will be measured from an established measuring point on the top edge of the casing. The depth to water will be measured using an electric or steel tape and will be recorded to the nearest 0.01 ft from the top of casing or measuring point. The depth to water in monitoring wells will be recorded to the nearest 0.01 ft, and the measurement will be repeated until two consecutive measurements are within 0.02 ft. All probes and equipment lowered down the well will be rinsed with deionized (DI) water and stored in a clean plastic bag between each use. All water-level measurements will be recorded on a ground-water quality field notes form (fig. 7) if such samples are collected or otherwise in a field notebook. If an electric tape or pressure transducer is used, the serial number and description of the equipment will be recorded.

3.1.1.2 Public- and Domestic-Supply Well Sampling

Public-water-supply wells will be sampled from the tap at the well head or tap nearest to the well head. Care will be taken to collect samples before in-line chlorination or other treatment is done. Attempts will be made to collect samples after wells have been running for a minimum of 30 minutes. If possible, wells will be allowed to run a sufficient time to remove a minimum of one pipe volume before sampling. Domestic wells will be sampled from a faucet at the well head or the faucet nearest to the well head. Faucets will be opened and allow to run freely at a sufficient volume to cause the pump to run continuously and remove a minimum of one pipe volume, if possible. Samples will be collected from a faucet between the well head and pressure tank, chlorinator, or water softener. Under no circumstances will samples be collected downstream from chlorinators or water softeners.

Field parameters (pH, temperature, specific conductance, and DO) will be measured and samples collected only after pH, temperature, and specific conductance have stabilized. Generally, field parameters may be measured in a small beaker. The beaker should be placed adjacent to the tap or hose outlet such that a small stream of sample water is continuously flowing into the beaker. Care will be used to avoid excess turbulence which may cause erroneous pH readings (streaming potential in low conductance waters) and DO measurements. DO measurements will be made using a DO meter if the DO concentration is 1 mg/L (milligram per liter) or greater or direct-reading vacuum vials if the DO concentration is less than 1 mg/L. Vial tips will be broken in a collection chamber supplied by the manufacturer or beneath the water surface of the beaker used for temperature, pH, and specific conductance measurements. Stabilization criteria are as follows: pH, within 0.5 unit; temperature, within 0.5 °C; specific conductance, within 2 percent; and DO, with 0.5 mg/L. Purging data and field measurements will be recorded on a ground-water quality field notes form (fig. 7).

Samples for VOC analysis will be put into 40-mL (milliliter) septum-capped amber vials with no headspace. Two vials will be filled for analysis by the portable GC (gas chromatograph), and three vials will be filled for laboratory analysis. The three vials submitted for laboratory analysis will be acidified to pH less than 2 by adding 2 drops of concentrated VOC-free HCL (hydrochloric acid) and chilled at 4 °C until shipment to the laboratory. Sample bottles for unfiltered inorganic and organic constituents will be filled directly from the tap or from a small length of Teflon tubing attached to the tap. Bottles will be filled in the following order: VOCs, physical properties, nutrients, semivolatiles and other unfiltered organics, and major and trace elements. For dissolved inorganic constituents, a peristaltic pump will be used to pump water from a 3-L (liter) Teflon bottle through a disposable 0.45-µm (micrometer) pore-size capsule filter using a flow rate of less than 500 mL per minute.

3.1.1.3 Monitoring Well Sampling

The monitoring wells will be sampled using a submersible stainless steel/Teflon fitted pump with a Teflon-lined discharge hose or disposable bottom-filling polyethylene bailers. Extreme care will be used during purging and sampling to avoid undue turbulence in the water column when raising and lowering the bailer or pump to minimize disturbance of solids settled in the bottom of the well or aeration and possible loss of VOCs. Purging of shallow (< 100 ft deep) monitoring wells will follow a modification of the USEPA micropurge protocol (U.S. Environmental Protection Agency, 1995). A minimum of two well volumes will be purged from each well before sampling. During purging, the pH, temperature, specific conductance, and DO of the water will be monitored, and samples will not be collected until these parameters have stabilized according to the following guidelines: pH, within 0.05 units; temperature, within 0.5 °C; specific conductance, within 2 percent; and DO, within 0.5 mg/L. In the event stabilization is not reached within 3 well volumes, the sample will be collected at the discretion of field personnel. For wells deeper than 100 ft where the pump orifice cannot be placed in the well screen or where wells have long (> than 40 ft) open intervals, a minimum of one well volume will be purged before sampling. Purging data, such as volume removed, purging rate, and stabilization of field measurements will be recorded on a ground-water quality field notes form (fig. 7).

Samples for VOC analysis will be placed into 40-mL septum-capped amber vials with no headspace. If the submersible pump is used, the flow rate will be lowered to about 250 mL per minute before sampling. Two vials will be filled for analysis by the portable GC, and three vials will be filled for laboratory analysis. The three vials submitted for laboratory analysis will be acidified to pH less than 2 by adding 2 drops of concentrated VOC-free HCL and chilled at 4 °C until shipment to the laboratory. If a bailer is used, sample bottles for physical properties and total inorganic and organic constituents will be filled directly from the bailer or filled from a 3-liter Teflon bottle. For dissolved inorganic constituents, a peristaltic pump will be used to pump water from the Teflon bottle through a disposable 0.45-µm pore-size capsule filter using a flow rate of less than 500 mL per minute. If a submersible pump is used, sample bottles for physical properties and total inorganic and organic constituents will be filled directly from the pump hose outlet. Samples for dissolved constituents will then be collected by attaching a capsule filter directly to the pump hose outlet and a flow rate of less than 500 mL per minute maintained. Bottles will be filled in the following order: VOCs, physical properties, nutrients, semivolatiles and other unfiltered organics, and major and trace elements.

### 3.1.2 Surface-water sampling protocol

Ambient concentrations of many trace elements and organic constituents in surface water range in the low microgram per liter range or smaller. The goal of USGS water-sampling procedures is to provide a standard and consistent protocol applicable to the collection of surface-water samples with analyte concentrations in the low to sub-microgram per liter range. General guidelines for the collection of surface-water samples are presented in this section. Surface-water samples generally will be collected according to established USGS procedures and those described in the following publications: Brown and others (1970), Edwards and Glysson (1988), Sheldon (1994), Ward and Harr (1990), Wilde and others (1998a and 1999a), and various USGS Technical Memoranda. Because of the multitude of situations encountered in the field, the guidelines described below will not cover all circumstances, and unique situations may require deviation from standard methodologies. In these cases, the best judgment of field personnel will be used and sample collection will be fully documented.

#### 3.1.2.1 Discharge

Streamflow, or discharge, is defined as the volumetric flow rate of water, including sediment or other dissolved or solid particles. The USGS expresses discharge in $ft^3/s$ (cubic feet per second). Generally discharge is measured using a current meter, although other methods such as flumes or recent techniques such as doppler radar occasionally are used. A detailed discussion of standard discharge-measurement techniques used by the USGS is given in Buchanan and Somers (1969) and Rantz (1982).

A determination of discharge will be made during the collection of water-quality samples from any river, stream, spring, or seep. Discharge for the Missouri River will be determined from a USGS gaging station on the Missouri River at Hermann, Missouri, about 15 mi upstream from New Haven. The standard technique for measuring discharge will involve the use of a current meter (type AA or pygmy). A suitable (most uniform channel and flow characteristics) stream section is selected, and the method of partial areas and average velocities is used to calculate the instantaneous discharge. The stream cross section is divided into a number of partial areas, and the current meter is used to measure the mid-point velocity of each partial area. The area of each partial area multiplied by the average velocity at the mid-point gives the discharge for each partial area, the sum of all of which is the total discharge.

Wading measurements generally will be made using a current meter attached to a standard 4-ft USGS wading rod. An attempt will be made to divide the cross section into enough partial areas such that the discharge of each partial area represents no more than 5 percent of the total discharge. A standard AA-type current meter will be used to measure velocities where average water depths are greater than 1.5 ft. A pygmy meter will be used where average depths are less than 1.5 ft. All relevant information regarding each discharge measurement will be recorded on a standard USGS discharge measurement notes form (fig. 8).

3.1.2.2 Stream Sampling

Where hydrologic conditions permit, the USGS will collect depth-integrated, flow-weighted, cross-sectional, surface-water composite samples from both the active and inactive parts of streams. Water will be collected from flowing parts of streams because constituents generally are well mixed. Active stream samples also will help to determine what is being transported downstream. Grab samples from quieter areas of streams near non-point sources such as landfills often are misleading because constituents are not mixed well in the cross section. Biased water-quality samples will be collected from the Missouri River upstream and downstream of the New Haven Riverfront site near the right bank and from near bottom using a submersible pump.

Most surface-water samples will be collected by a non-contaminating isokinetic sampler using the depth-integrated, equal-width interval (EWI) method. The primary sampler used for surface-water sampling will be a teflon USGS DH-81 (hand suspended) equipped with a 1- or 3-L teflon bottle. The DH-81 sampler is fitted with a variety of intake nozzles that, when properly used, allow the collection of a depth-integrated isokinetic sample from the stream. A number of vertical sections are collected across the stream and composited to generate a flow-weighted composite sample of the stream. The nozzle size used on the sampler is selected based on the bottle size and stream velocity. Samples are collected by lowering the sampler below the water surface at a constant rate equal to no greater than 20 percent of the mean velocity to the stream bottom and raising at the same rate. Five to 10 cross sections will be made, depending on the flow characteristics of the stream and the sample volume required. Streams with insufficient discharge, depths (less than about 0.5 ft), or mean flow velocities [less than 1 ft/s (foot per second)] to use the DH-81 sampler will be sampled using a hand-dip method. Bottles should be pointed upstream above the water surface and lowered beneath the water surface at several increments across the stream (or centroid of flow if the stream is narrow and seems well mixed) until the bottle is nearly filled. If more than 2.5 L of sample is required (operational capacity of 3-L DH-81) then subsamples will be placed into a compositing container. Compositing containers that may be used include: (1) standard USGS churn splitter (inorganic constituents and nutrients only), (2) glass 4-L amber bottle (organic constituents and nutrients), and (3) 3-L teflon bottle (suitable for all constituents). VOC samples should be collected directly from the stream into 40-mL septum-capped amber vials with no headspace. Samples for laboratory analysis of VOCs will be preserved as described in section 3.1.2.1.

Samples for physical properties and total inorganic and organic constituents may be collected directly from an appropriate compositing container. After water-sediment mixture samples are obtained, the remaining composite sample will be used to provide filtered samples designated for dissolved inorganic constituent analyses. For dissolved inorganic constituents, a peristaltic pump will be used to pump water from the compositing container through a disposable 0.45-µm pore-size capsule filter using a flow rate of less than 500 mL per minute. DO, specific conductance, and temperature will be measured in the stream near the centroid of flow. pH and alkalinity measurements will be done on separate sample aliquots of composite sample water immediately after collection. All field measurement values will be recorded on the surface-water field notes form shown in fig. 9.

3.1.2.3 Spring and Seep Sampling

Small springs and seeps will be sampled at the orifice or as near the orifice as possible using the hand-dip method described in Section 3.1.2.2. Field measurements will be made from the spring or seep orifice, if possible. VOC samples will be collected directly from the spring or seep by filling 40-mL VOC vials. If insufficient flow is available for this method, water from the spring or seep will be pooled by digging a small hole at or beneath the seep orifice with a hand spade. After the pool has filled, the VOC vials will be filled by removing the cap, immersing the vial and cap beneath the surface, and capping the vial beneath the surface. After the collection of VOC samples, the DO, specific conductance, and temperature will be measured by immersing the appropriate electrodes directly in the spring or seep. pH and alkalinity measurements will be done on separate sample aliquots of collected directly from the spring or seep or from an appropriate compositing container immediately after collection. Samples for laboratory analyses of VOCs will be preserved as described above. Samples for total inorganic and organic constituents may be collected directly from the spring or seep or from an appropriate compositing container. After water-sediment mixture samples are obtained, the remaining composite sample will be used to provide filtered sampled designated for dissolved inorganic constituent analyses using the procedure described in section 3.1.2.2. All field measurement values will be recorded on the surface-water field notes form (fig. 9).

### 3.1.3 Soil samples

3.1.3.1 Surficial Soil Sampling

Soil borings will be performed generally at the nodal locations of a pre-defined grid system. The borings will be done using a hand-operated soil boring kit containing a self-augering bucket head, multiple lengths of steel extension rods with attachable handle, a coring bit driving tool, a 6-in long hollow stem steel soil coring bit (either 1-½ in or 2-in diameter), and stainless steel coring collars. The borehole will be advanced using the auger bucket to a pre-determined depth where a core sample will be collected. Core samples will be collected from the bottom of the borehole by driving the steel coring bit 6 inches through the bottom of the borehole until the coring collar is full. Soil samples will be collected at various depths to represent surface (0 to 2 ft) and subsurface (greater than 2 ft) media. Generally, samples will be collected every 2 to 3 ft of depth.

Soil samples will be either field analyzed for VOCs using a portable GC or be sampled and shipped to the laboratory for analysis. For field analysis, a 10cc disposable plastic syringe with the top removed will be used to collect approximately 5 g (4 to 5 cc volume) of sediment sample from the bottom of the coring collar. That sample will be placed in a 40-mL septum-capped amber vial and sufficient organic-free water will be added to reach a total volume of 20 mL. The vial with the sample will either be immediately heated on a heater block for 15 minutes and the headspace analyzed for VOCs or else chilled at 4 °C until analysis can be performed. For laboratory analysis, the sediment will be collected from the bottom 5 inches of the collar to prevent cross-contamination from slough falling in from above. The sample will be packed in a 4-oz plastic-capped glass jar in such a way to remove any headspace within the jar and chilled at 4 °C until shipment to the laboratory.

Composite samples will be analyzed for grain size, SVOCs (semivolatile organic compounds), TCLP-VOCs (Toxic Characteristics Leachate Procedure), PCBs (polychlorobiphenyls), organochlorine pesticides, and metals. Subsamples will be composited in a stainless-steel container, homogenized, and subsampled for analysis. The subsamples will be packed in two 4-oz glass jars and chilled at 4 °C until shipment to the laboratory.

3.1.3.2 Streambed-Sediment Sampling

The goal of the streambed-sediment sampling is to determine if trace quantities of anthropogenic inorganic and organic constituents are present in streambed sediment as a result of activity in New Haven. To achieve this goal, a biased streambed sampling effort will be conducted. The objective of this effort is not to fully characterize the distribution and mass and type of anthropogenic compounds in streambed sediment but to determine if the specific OUs have impacted streambed sediments to any degree. USGS procedures for collecting streambed-sediment samples are described in Shelton and Capel (1994) and Radtke (1997).

Streambed sediment will be collected only during low base-flow conditions from selected sites on the Missouri River on the right edge of water near New Haven. Stream sections containing fine-grained bed sediment will be selected for sampling if possible. Because of the water depth, a dredge (Eckman, ponar, or equivalent) will be used. The part of the sample in contact with the sampler, such as the outside of a core, will be removed to avoid possible contamination from the sampler. Attempts will be made to composite a minimum of 3 subsamples from each sampling site directly into a stainless steel bowl to achieve a final sample of about 1 kg (kilogram). Large debris, such as twigs and large rocks, will be removed before dividing the composite sample into 4-oz plastic-capped glass jars and chilled at 4 °C until shipment to the laboratory. Streambed-sediment samples will be analyzed for the same constituents as soils with the exception of VOCs.

### 3.1.4 Tree-core samples

A tree core sample will be taken from a site where information is desired about the VOC concentration in the shallow ground water. The wood of the tree is made of cells that carry ground water from the roots up to the leaves. It is this water that is being sampled when a tree core is obtained.

A standard U.S. Forest Service ¼ x 4-in tree boring tool with core removal spoon will be used to collect a tree core sample. The tree that is selected to sample will have a diameter of approximately 3 in or larger, with preference to trees that are known to have well-developed root systems such as mulberry or poplar trees. Once the tree has been selected, the borer will be held horizontally between 2 and 3 ft from the base of the tree and twisted clockwise into the tree to a distance of at least 2 in. The tip of the borer is hollow, so as it twists, it screws around a pencil-sized section of tree. The borer is then removed from the tree by twisting counter-clockwise. Once the borer has been removed from the tree, the core will still be inside the borer and needs to be extracted. The core removal spoon that is part of the boring tool will be used to push the core out. As it is pushed out, it will be placed immediately into a weighed 40-mL septum-capped amber vial. The fresh core and container will then be weighed again and refrigerated until the sample can be analyzed. Once the core has been removed, the tree borer will be decontaminated by rinsing with DI water. If the tree is 8 in or greater in diameter, multiple cores may need to be taken. For trees ranging from 8 to16 in, two cores will be taken $180^{o}$ from each other, offset either up or down by 3 to 6 in. Trees larger than 16 in will have 3 to 4 cores taken, $90^{o}$ to $120^{o}$ from each other depending on the number of cores, also offset from each other. The multiple cores will be placed into the same vial if they are from the same tree to give an overall composite core of the tree.

The tree cores are equilibrated overnight at room temperature, and the headspace is analyzed on the portable GC. When the analysis of the core is complete, the core will be dried in an oven at 95 °C for 12 hours. The weight of the dry core and holding container will then be compared to the previous weights, allowing for the mass of the core, and the mass of the water within the core to be calculated. This allows a direct correlation to be drawn between the amount of VOCs detected and the percent water in the core.

### 3.1.5 Metal Detection and Underground Void Location Techniques

To detect buried metal and underground voids, the CBP2 industrial metal detector manufactured by White's Electronics, Inc.[4], will be used. This metal detector is designed to locate large quantities of metal, such as 55-gallon drums, and also underground voids, such as abandoned cisterns at depths up to 20 feet.

Before using the detector, the operator will remove all metal such as belt buckles, watches, and steel-toe boots. The batteries will be checked to ensure good ground penetration, and the overall appearance of the detector and its two antennas will be inspected for damage that may inhibit performance ability. The detector will then be set for the type of target desired, metal or void. Once the type of target is determined, the detector will need to be calibrated. The calibration procedure outlined in the operating manual will be followed. This calibration allows for the detector to perform with little interference from electrical sources or ground minerals.

The detector has two modes, one for locating a target by walking, and one for locating while standing. For either mode, the detector will be held at waist level (approximately 18 inches from the ground). The detector will produce an increase in sound when a target is approached. The sound will increase and decrease as the detector is moved closer and further from the target.

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[4] Use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

The designated survey area will need to be sectioned off into a rectangular grid, approximately 2 to 4 ft wide in spacing. Temporary orange-flagged stakes will be staggered at the end of the rectangles to help keep consistency. If the length of the grid exceeds 25 ft, then the grid will be broken up into smaller grids and marked with orange flagging, enabling the operator to cover all of the area evenly. The detector will be walked back and forth through each grid until it sounds, marking a target nearby. To pinpoint the location of a target, the detector will be slowly crossed over the sounding area from at least two sides in the form of an 'X'. Once the target has been pinpointed, its center will be marked. Depending on the type of target, the approximate depth underground may be determined. This will be done using the outlined procedures in the operating manual, but for location purposes is optional due to the maximum depths being 20 feet or less. Once the location of the target has been pinpointed and the depth estimated, it will be logged either in a field notebook, on a topographic map, or by a portable GPS for further investigation.

## 3.2 Sample Handling and Custody

The analytical method, reporting level, sampling containers, required volume, preservation, and sample hold times by analyte for water and soil samples are presented in table 4. The description of the preservation codes is presented in table 5. A field notes form is filled out each time a ground- or surface-water sample is collected (figs. 7 and 9). Both forms contain pertinent information on field personnel, sampling conditions, equipment used, instrument calibration, and field measurements. In addition, the surface-water quality field notes form contains information on stream stage and discharge, and the ground-water quality field notes form contains information on well type and purging records. USGS sample handling protocols, including compositing, splitting, filtration, preservation, labeling, and shipping are described in Wilde and others (1999b). The following are general descriptions of sample handling and custody protocols.

**Table 4.** Analytical methods, required volumes, preservation, and analytical holding times for soil and water samples.
[VOC, volatile organic compound; GC-MS, gas chromatograph-mass spectrometer; µg/L, micrograms per liter; mL, milliliter; HCL, hydrochloric acid; ICP, Inductively Coupled Argon Plasma; mg/kg, milligrams per killigram; oz, ounce; µg/kg, micrograms per killogram; TCLP, Toxicity Characteristic Leaching Procedure; SVOC, semivolatile organic compound; GC-ECD, gas chromatograph-electron capture detector; PCB, polychlorobiphenyls; µS/cm, microsiemens per centimeter at 25 $^{o}$C; ICP, Inductively Coupled Argon Plasma; mg/L, milligrams per liter; AA, Atomic Absorption; IC, ion-exchange chromatography; ISE, ion specific electrode; N, nitrogen; AAGF, Atomic Absorption Graphite Furnace; RCRA, Resource Conservation Recovery Act; ICP-AES, Inductively Coupled Argon Plasma-Atomic Emission Spectrometry; EE, Electrolytic Enrichment; pCi/L, picocuries per liter]

| Method number | Analytes | Analytical method | Reporting level | Volume | Preservation code[1] | Hold time (day) |
|---|---|---|---|---|---|---|
| **Organic constituents** | | | | | | |
| USGS 1307[2] | Volatile organic compounds (VOC), total in water | GC-MS | 0.1 µg/L for most compounds | Three 40-mL vials | pH <2 with 2 drops HCL; chilled to 4$^{o}$C. | 14 |

| | | | | | | |
|---|---|---|---|---|---|---|
| USGS 4054[2] | Volatile organic compounds (VOC), total in water | GC-MS | .1 µg/L for most compounds | Three 40-mL vials | pH <2 with 2 drops HCL; chilled to $4^{o}C$. | 14 |
| EPA 8260B (5030 or 5035)[3] | Volatile organic compounds (VOC), total in soil | GC-MS | 6 µg/kg for most compounds | Two 4-oz glass jars [4,5] | Chilled to $4^{o}C$ | 14 |
| EPA 1311 | TCLP-VOCs, total in soil | GC-MS | | Two 4-oz glass jars[4,5] | Chilled to $4^{o}C$ | 14 |
| EPA 8270C (3550B) [3] | Semivolatile organic compounds (SVOC), total in soil | GC-MS | 350-410 µg/kg for most compounds | Two 4-oz glass jars[4] | Chilled to $4^{o}C$ | 14 |
| EPA 8081A (3550B) [3] | Organochlorine pesticides, total in soil | GC-ECD | 2 µg/kg for most compounds | Two 4-oz glass jars[4] | Chilled to $4^{o}C$ | 14 |
| EPA 8082 (3550B) [3] | PCBs, total in soil | GC-ECD | 35-41 µg/kg for most compounds | Two 4-oz glass jars[4] | Chilled to $4^{o}C$ | 14 |
| **Physical properties, inorganic constituents, and tritium** | | | | | | |
| I-1780-84 | Specific conductance, lab | Electrometric | 1 µS/cm | 100 mL | RU | 7 |
| I-1586-85 | pH, lab | Wheatstone bridge | 0.1 unit | 100 mL | RU | 7 |
| EPA 200.7 | Calcium and magnesium, dis. | ICP | 0.02/.03 mg/L | 250 mL | FA | 180 |
| I-1630-85 | Potassium, dis. | AA | .01 mg/L | 250 mL | FA | 180 |
| I-1735-85 | Sodium, dis. | AA | .01 mg/L | 250 mL | FA | 180 |
| EPA 200.7 | Silica, dissolved | ICP | .01 mg/L | 250 mL | FA | 180 |
| EPA 300.0 | Chloride and sulfate, dis. | IC | .05/.07 mg/L | 250 mL | FU | 28 |
| I-2327-85 | Fluoride, dis. | ISE | .1 mg/L | 250 mL | FU | 28 |
| I-4545-85 | Nitrate plus nitrite, total as N | Colorimetric Cd reduction | .002 mg/L | 125 mL | RCC | 28 |
| I-4522-85 | Ammonia, total as N | Colorimetric | .002 mg/L | 125 mL | RCC | 28 |
| I-4601-85 | Phosphorus, total | Colorimetric | .002 mg/L | 125 mL | WCA | 28 |
| EPA 206.2 | Arsenic, dis. | AAGF | .5 µg/L | 250 mL | FA | 180 |
| EPA 204.2 | Antimony, dis. | AAGF | .5 µg/L | 250 mL | FA | 180 |
| EPA 200.7 | Barium, dis. | ICP | .50 µg/L | 250 mL | FA | 180 |
| EPA 200.7 | Beryllium, dis. | ICP | 1.0 µg/L | 250 mL | FA | 180 |

| | | | | | | |
|---|---|---|---|---|---|---|
| EPA 200.7 | Boron, dis. | ICP | 2.0 µg/L | 250 mL | FA | 180 |
| EPA 213.2 | Cadmium, dis. | AAGF | .25 µg/L | 250 mL | FA | 180 |
| EPA 200.7 | Chromium, dis. | ICP | 1.0 µg/L | 250 mL | FA | 180 |
| EPA 219.2 | Cobalt, dis. | AAGF | .5 µg/L | 250 mL | FA | 180 |
| EPA 220.2 | Copper, dis. | AAGF | .5 µg/L | 250 mL | FA | 180 |
| EPA 200.7 | Iron, dis. | ICP | 2.0 µg/L | 250 mL | FA | 180 |
| EPA 239.2 | Lead, dis. | AAGF | .5 µg/L | 250 mL | FA | 180 |
| I-1472-87 | Lithium, dis. | ICP | 1.0 µg/L | 250 mL | FA | 180 |
| EPA 200.7 | Manganese, dis. | ICP | 1.0 µg/L | 250 mL | FA | 180 |
| EPA 246.2 | Molybdenum, dis. | AAGF | 1.0 µg/L | 250 mL | FA | 180 |
| EPA 249.2 | Nickel, dis. | AAGF | .50 µg/L | 250 mL | FA | 180 |
| EPA 272.2 | Silver, dis. | AAGF | .3 µg/L | 250 mL | FA | 180 |
| I-1472-87 | Strontium, dis. | ICP | 0.5 µg/L | 250 mL | FA | 180 |
| EPA 279.2 | Thallium, dis. | AAGF | 0.5 µg/L | 250 mL | FA | 180 |
| EPA 200.7 | Vanadium, dis. | ICP | 1.0 µg/L | 250 mL | FA | 180 |
| EPA 200.7 | Zinc, dis. | ICP | 2.0 µg/L | 250 mL | FA | 180 |
| EPA 6010B | RCRA metals, total in soil | ICP-AES | 1 mg/kg for most metals | Two 4-oz glass jars[4] | Chilled to 4$^{o}$C | 180 |
| USGS 1043 | Tritium, total | EE | .3 pCi/L | 1 L | RUS | |

[1] Preservation codes are described in table 5. When multiple analytes require the same preservation, the volume listed is the total volume required for the various analytes.
[2] USGS 1307 includes 29 regulated VOCs and will be the regular schedule used for the analysis of VOCs in water. USGS 4054 includes the 29 regulated VOCs plus 56 additional VOCs and will be used once during the RI for the analysis of VOCs in water. Both methods are modifications of USEPA 524.2.
[3] Number in parentheses is USEPA sample preparation method number.
[4] EPA 6010B, 8260B, 8270C 8081A, and 8082 can all be done with two 4-oz glass jars of sample.
[5] Standard USEPA protocol for VOCs in soils is to fill two 40-mL VOC vials. This technique will not be used because of the potential for VOC loss while filling the vials. It can take several minutes to fill the vials versus 10 to 20 seconds to fill a 4-oz glass jar. This time difference is critical in warm weather.

**Table 5.** Description of preservation codes.
[mL, milliliter; µm, micrometer; N, normal; L, liter]

| Code | Description |
|---|---|
| RU | Raw (unfiltered) untreated water sample. Sample is placed into a 250-mL polyethylene bottle and shipped to the laboratory without treatment or preservation. Bottle is field rinsed with unfiltered sample. |
| FA | Field filtered water sample. Sample is filtered using a 0.45 µm disposable capsule filter. Filtrate is placed into a 250-mL polyethylene bottle and acidified to pH less than 2 using 2 mL of trace-metal grade nitric acid. The preservative is supplied in individual 2-mL ampules. Bottles are rinsed with 10% nitric acid at the laboratory and are not field rinsed. |
| FU | Field filtered water sample. Sample is filtered using a 0.45µm disposable capsule filter. The filtrate is placed in a polyethylene bottle and shipped to the laboratory without additional treatment. Bottle is field rinsed with filtered sample. |

| | |
|---|---|
| RCC | Raw (unfiltered) water sample. Sample is placed into a 125-mL amber polyethylene bottle and chilled to 4 °C for shipment to the laboratory. Bottle is rinsed with unfiltered sample. |
| WCA | Raw (unfiltered) water sample. Sample is placed into a 125-mL polyethylene bottle and acidified with 1 mL of 4.5 N sulfuric acid and chilled to 4 °C. The preservative is supplied in individual ampules. Bottle is rinsed with unfiltered sample. |
| RUS | Raw (unfiltered) water sample. Sample is placed into a 1-L polyethylene bottle. Bottle is rinsed with unfiltered sample. |

### 3.2.1 Compositing

Individual water samples collected for determination of inorganic and nonvolative constituents from surface-water sites, springs, or seeps using the EWI method and a DH-81 sampler or a bottle (hand-dip method) should be composited into a single representative sample. VOC samples will not be composited. Ideally, the compositing container should be made from Teflon which is suitable for inorganic and organic analyses. If a single suitable compositing container is not available or impractical to use, the composite sample may be placed into two separate containers, one for inorganics made of suitable plastic, such as polyethylene (for example, USGS churn splitter), and one for organics (stainless steel or glass). Under no circumstances should water for organics analyses come into contact with materials other than teflon, glass, or stainless steel. Likewise, samples for inorganic analyses should never be placed in contact with metal or metal-containing plastics (most color plastics, neoprene, or rubber). Glass compositing containers are not recommended if trace inorganic constituents are to be analyzed because of potential contamination by boron and other constituents in the glass.

Surficial soil samples and streambed-sediment samples should be composited and homogenized in a stainless-steel container. Mixing and homogenization should be done using a stainless-steel spoon, Teflon-coated stainless spoon, or equivalent. Large rocks and twigs should be removed carefully using tweezers or equivalent device. After the composite sample has been mixed, fill two 4-oz glass jar using a non-contaminating spoon or spatula by inserting the spoon/spatula to the bottom of the compositing container and bring it carefully up through the entire thickness of material. Place one spoon in each consecutive sample container and repeat the process until the appropriate volumes are present in each sample container. Ideally, 5 to 10 passes should be required to fill the sample containers, ensuring the most representative splitting of the composite sample. Care must be used to avoid the loss of fine-grained material suspended in the water when compositing streambed-sediment samples.

### 3.2.2 Splitting

Splitting of soil and streambed-sediment samples should be done according to the method described in Section 3.2.1. When possible, the USGS churn splitter or cone splitter should be used to split all surface water, spring, and seep samples collected for the determination of inorganic and nonvolatile constituents.

### 3.2.3 Sample Containers and Filtration

Samples are drawn from the compositing containers and packaged in the required sample-shipping container according to the proper preservation code (table 5). All samples except those requiring filtration can be filled directly from the compositing container. Sample containers for physical properties or total or dissolved inorganic constituents should be rinsed with native water (filtered for dissolved constituents) prior to filling with the sample. Sample containers for organic constituents have been baked at 450 °C to remove organics and should not be rinsed with native water.

Sample aliquots for inorganic analysis requiring filtration are obtained using a variable speed, reversible flow battery-operated peristaltic pump, which forces the raw water through a 0.45-μm pore-size disposable capsule filter. The peristaltic pump should be equipped with silicon or C-flex tubing that has been cleaned to ensure no cross contamination between sampling sites.

### 3.2.4 Sample Preservation

Many ions and compounds present in natural water, streambed-sediment, or soil samples may degrade or be removed by chemical and physical reactions such as oxidation, reduction, precipitation, adsorption, and ion exchange. To reduce or prevent the loss of ions or organic compounds from water samples, a variety of sample preservation treatments are used by the USGS (table 5). Preservation treatments for this project include chilling and the addition of sulfuric acid and nitric acid. Sample aliquots required to be chilled to 4 °C shall be placed in ice-filled coolers in preparation for shipment.

### 3.2.5 Sample Labeling and Shipping

Sample containers will be labeled in the field at each sampling location using preprinted, adhesive-backed labels that contain the station number and name, date, time, laboratory schedule or lab code number, and preservation code. Each sample bottle will be wrapped with clear cellophane tape to ensure the integrity of the label.

The USGS will follow USEPA Region VII Chain-of-Custody (COC) protocols. Before leaving a site, a COC form (fig. 10) will be filled out that will accompany the samples through shipping and analysis. Field personnel will keep one copy of the COC form and ship the remaining copy with the samples. At the conclusion of each field day, an Analytical Services Request (ASR) form is prepared for each sampling site for samples shipped to the USGS National Water-Quality Laboratory (NWQL) in Lakewood, Colorado, or to the USGS Quality Water Service Unit (QWSU) in Ocala, Florida (fig. 11). The ASR form indicates the station number and name, date and time of collection, hydrologic conditions, sample media, analyses requested, number and types of sample containers, and person shipping the samples. For samples shipped to the USGS contract laboratory, the COC form serves as the ASR (fig. 12).

Samples are shipped in coolers overnight by Federal Express to the NWQL, QWSU, or USGS contract laboratory. Coolers will be shipped from the Missouri District office or the field, making sure that holding times (table 4) are not exceeded. All relevant information on the sample labels, ground- or surface-water quality field notes form, and the COC forms will be checked before the samples are packed for shipment. All glass bottles will be placed in foam sleeves or bubble wrap for shipment. All samples required to be chilled will be shipped with a sufficient quantity of ice to maintain the samples at a temperature of 4 °C, and the coolers will be double lined with sealed plastic trash bags to prevent leakage.

Upon reaching the laboratory, shipments are inspected for damage, temperature, and holding times. The sample containers and corresponding ASR and COC forms are checked against each other, and the samples are logged in. Sample log in involves assigning to each sample a unique laboratory number through the Laboratory Information Management Systems (LIMS). The LIMS is a computerized data-management system that also stores other essential sample information and is used to track each sample through the laboratory until analysis is complete and results have been reported. Samples are then retained for 6 months in the event a rerun is needed, after which samples are disposed of in accordance with regulatory requirements. After all analytical data for a given sample have been completed and quality assured, the data are entered into the USGS National Water Information System (NWIS) or other electronic format for transfer to the Missouri District data base.

## 3.3 Field Equipment

Project personnel are responsible for the proper operation, calibration, and decontamination of all field instruments and equipment. USGS protocols for field instrument and equipment operation, calibration, and decontamination are described in Wilde and Radtke (1998) and Wilde and others (1998b). The following are general descriptions of instrument calibration and equipment decontamination.

### 3.3.1 Calibration of Field Instruments

All water-quality field instrumentation must be calibrated at the beginning of each sampling day according to the manufacturer's specifications. Additionally, a calibration check of all meters must be performed by running at least one standard every 4 hours. At the end of the sampling day, a calibration check of all field instruments must be performed to ensure that the calibration curve has not changed beyond acceptable limits.

#### 3.3.1.1 Specific Conductance

In the field, check calibration with conductance standards of known values within the range of anticipated sample conductance. Recalibration of an instrument or a calibration curve drawn from a series of standards is indicated for meters determined to be more than 2 percent off calibration. Routine calibration is a two-point calibration check bracketing the expected sample value. Readings of the standard will be compared to a previously determined calibration curve. If one or both of these readings do not fall within 2 percent of the expected reading, the cables, battery, and probe will be checked and the calibration attempted again. Record calibration readings on the water-quality field notes form along with the name of the analyst, type of meter (make and model), lot numbers of conductance standards, and date and time that calibration and calibration checks were performed. All meters used for the project are temperature compensated. Reporting units are µS/cm (microsiemens per cubic centimeter at 25 °C).

#### 3.3.1.2 pH

In the field, check calibration with two pH buffers of known value within the range of anticipated sample pH. Buffer values should be chosen so that they bracket the anticipated sample pH. Buffer temperature must be very close to sample temperature, preferably within 1 °C. Make sure the pH probe electrolyte level is full, the vent cap is open, and standardize on the pH 7 buffer first. Check the second buffer to set the slope. Recheck the pH 7 buffer. The reading must be within 0.02 pH unit or the calibration has failed. Between each sampling site, check the pH 7 buffer. If the reading is not within 0.02 pH unit, recalibration is necessary. Record calibration readings on the water-quality field notes form along with the name of the analyst, type of meter (make and model), lot numbers of pH buffers, and date and time that calibration and calibration checks were performed.

3.3.1.3 Dissolved Oxygen

In the field, DO is calibrated using the air calibration in air method. The DO probe is placed in a 100 percent water-saturated environment, and the atmospheric pressure and temperature measured. Using oxygen saturation tables, the oxygen value at the measured atmospheric pressure and temperature is determined, and the DO meter is adjusted if necessary. Record calibration readings on the water-quality field notes form along with the name of the analyst, type of meter (make and model), and date and time that calibration and calibration checks were performed.

3.3.1.4 Portable Gas Chromatograph

Initial calibration is done according to manufacturer's specifications. After warming up the instrument for 45 minutes and a base-line check, run an initial air blank. A standard mix should be prepared by placing 5 µL (microliter) of USGS PID mix into 20 mL of organic-free water in a VOC vial. This will result in a water standard with the following concentrations: PCE (13 µg/L), TCE (13 µg/L), cis-DCE (25 µg/L), trans-DCE (8 µg/L), benzene (8 µg/L), toluene (8 µg/L), ortho xylene (28 µg/L), and ethyl benzene (27 µg/L). The standard vial should be inverted and placed into a block heater set at 40 °C. After 20 minutes, inject 250 µL of the standard using a dedicated syringe. Concentrations should read within 30 percent of the expected values, and retention times should be within 7 percent or calibration has failed. Samples to be scanned in the field will be collected in VOC vials and chilled. Prior to analysis, the vial will be opened and about 20 mL poured out. The vial will then be capped quickly, shaken 100 times, inverted, and placed in the block heater for 20 minutes before injection. The standard mix will be run every 15 samples or every 4 hours during the day. A blank will be run after every standard and after each sample containing concentrations of one or more compounds equal to or exceeding 10 times those in the standard mix.

### 3.3.2 Equipment Decontamination

All water-quality, streambed-sediment, soil, and tree core sampling and support equipment (such as DH-81 samplers, compositing containers, peristaltic pump hose, submersible pumps, pump hoses, steel or electric tapes, and soil boring kit) will be decontaminated thoroughly prior to and between each use according to USGS protocols described in Wilde and others (1998b). The general decontamination protocol to be followed for sampling equipment is a 0.1 percent Liquinox-tap water wash and scrub followed by successive rinses in tap water and DI water. If organic samples are collected, the DI water rinse is followed by a methanol rinse and double rinse with organic-free DI water. If trace element samples are collected, the tap water rinse is followed by a dilute HCL rinse and DI water rinse. Acid solutions should not be used on any sampling device containing metal. Decontamination of submersible pumps and hoses between sampling sites in the field should be done by pumping several liters of DI water through the pump and hose followed by several liters of native well water. Each water-quality vehicle should be equipped with approximately 30 L of DI water, 4 L of dilute HCl, 500 mL of methanol, and 2 L of organic-free DI water for field cleaning of equipment.

Sampling and support equipment should be washed with a 0.1 percent Liquinox-tap water solution followed by a tap water and DI water rinse in the laboratory after each field trip. For equipment used to collect organic samples, the DI water rinse is followed by a methanol rinse and double rinse with organic-free DI water. For equipment used to collect trace element samples, the tap water rinse is followed by a dilute HCL rinse and DI water rinse. Ground-water sampling pumps should be thoroughly cleaned in the laboratory after each sampling trip by completely disassembling the pump. Pump hoses can be cleaned in the laboratory by pumping a 0.1 percent Liquinox-tap water solution through the pump and hose followed by pumping copious quantities of tap water and several gallons of DI water through the hose. The tap water and tap water collected from the pump hose outlet are analyzed quarterly for VOCs.

#### 3.3.3 Sampling Containers and Supplies

In general, all sample containers shall be supplied by the USGS NWQL, QWSU, or USGS contract laboratory. Containers will be certified contaminant free. All preservatives (such as acids for trace element preservation) used will be obtained from the QWSU and are quality assured. All preservatives are individually packaged in ampules and identified by lot number. The lot number of each ampule used for each sample is recorded on the water-quality field notes form.

### 3.4 Analytical Methods

Analytical methods were selected based on the identified QA goals. The USGS NWQL, USGS QWSU, or USGS contact laboratory will perform all analyses. The USGS generally uses proven, documented methods, or USEPA methods for most analytical work. The methods are classified as follows: USGS approved or interim-approved method, non-USGS published standard method [such as American Society for Testing Materials (ASTM) and USEPA methods], and custom methods. The USGS methods are validated (including precision and accuracy data), externally reviewed, and published either as a USGS Techniques of Water-Resources Investigation Report (TWRI) or Open-File Report (OFR). Interim and custom methods are internally reviewed and validated. Before a USGS laboratory uses a non-USGS method, the laboratory first demonstrates its ability to run the method according to published criteria. External performance audits also may be done. The analytical methods used to analyze water, soil, and streambed-sediment samples are listed in table 4.

#### 3.4.1 General Description of Analytical Methods

##### 3.4.1.1 Volatile Organic Compounds in Water, Soil, and Sediment

Concentrations of VOCs in water, soil, and streambed-sediment samples will be determined using a portable GC, which is suitable to determine the presence/absence of VOCs in water, soil, and streambed-sediment samples. Results of the field GC also will provide a general estimate as to the magnitude of VOCs detected in water, soil, and streambed-sediment samples. Generally, detection levels for PCE, TCE, cis-DCE, and trans-DCE range between 0.1 and 0.5 μg/L; the detection level for VC is about 5 μg/L. The portable GC analyses will be done using a Photovac 10Splus equipped with a CPSIL-5 capillary column. Zero-grade air is used as the carrier gas which is purged through the column at a rate of 7.5 mL/min. Analysis time is 600 seconds at a column temperature of 40 °C. A gas-tight microsyringe is used to inject 250 μL of headspace from a 40-mL VOC vial into the analytical column. For soil analysis, 5 g of soil is placed into a VOC vial with 20 mL of organic-free water. For water analysis, 20 mL of sample is placed into a 40-mL VOC vial. The vial is shaken 100 times, inverted, and placed in a block heater at 40 °C for 20 minutes before analysis. Dilutions are accomplished by injecting smaller volumes of headspace into the GC.

The results of the portable GC will be confirmed by split samples (10 percent) for laboratory analysis using a modification of USEPA method 524.2 (water; Rose and Schroeder, 1995) or USEPA method 8260B (soil and streambed sediment). Both methods are analyzed by purge-and-trap GC-MS (gas chromatograph-mass spectrometer). For water samples, VOCs are extracted from the sample matrix by bubbling an inert gas through the sample (USEPA method 5030). Purged sample components are trapped in a tube containing suitable sorbent materials. When purging is complete, the sorbent tube is heated and backflushed with helium to desorb the trapped sample components into a narrow-bore capillary GC column interfaced to a MS. The column is temperature programmed to facilitate the separation of the analytes, which are then detected with the MS. Compounds eluting from the GC column are identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a data base.

For soil and streambed-sediment samples, VOCs are extracted from the sample using USEPA method 5035 for low concentrations of VOCs (0.5 to 200 µg/kg) or a modification of USEPA method 5030 for high concentrations of VOCs (greater than 200 µg/kg). For low VOC concentrations, the sample container is heated to 40 °C and the volatiles purged into an appropriate trap using an inert gas combined with agitation of the sample.

#### 3.4.1.2 Toxicity Characteristic Leaching Procedure for VOCs in Soil and Sediment

The TCLP-VOC (USEPA method 1311) is designed to determine the mobility of VOCs in water, soil, and sediment. If an analysis of the sample demonstrates that individual analytes are not present or are present at such low concentrations that the appropriate regulatory levels could not be exceeded, the TCLP need not be run. For soil and sediment samples, a zero-headspace extraction (ZHE) vessel is used to obtain TCLP extract for analysis of VOCs. This type of vessel allows for initial liquid/solid separation, extraction, and final extract filtration without opening the vessel. The extraction fluid consists of a mixture of glacial acetic acid, sodium hydroxide, and water at a pH of about 4.9. Following collection of the TCLP extract, store with minimal headspace at 4 °C until analyzed by purge-and-trap GC-MS.

#### 3.4.1.3 Semivolatile Organic Compounds in Soil and Sediment

Soil and streambed-sediment samples will be analyzed for SVOCs using GC-MS (USEPA method 8270C). The samples are prepared for analysis using ultrasonic extraction (USEPA method 3550B). The extract is separated from the sample by vacuum filtration or centrifugation. The SVOCs are introduced into the GC-MS by injecting the sample extract into a GC with a narrow-bore fused-silica capillary column. The GC column is temperature programmed to separate the analytes, which are then detected with a MS.

#### 3.4.1.4 Organochlorine Pesticides and PCBs in Soil and Sediment

Soil and streambed-sediment samples will be analyzed for organochlorine pesticides and PCBs (polychlorobiphenyls) using fused-silica, open-tubular, capillary GC columns with an electron capture detector (GC-ECD; USEPA method 8081A and 8082, respectively). The samples are prepared for analysis using ultrasonic extraction (USEPA method 3550B). After cleanup, the extract is analyzed by injecting a 1- or 2-µL aliquot into the GC-ECD. In addition, extracts for PCB analysis may be subjected to a sulfuric acid/potassium permanganate cleanup (USEPA method 3665).

3.4.1.5 Grain Size and Major and Trace Elements in Soil and Sediments

Soil and streambed-sediment samples will be analyzed for grain size (sand, silt, and clay-sized material) and major and trace elements. About 250 g of sample should be collected in a zip-lock bag or plastic jar. Grain-size analysis and clay separation (clay-size fraction) are made using modification of standard USGS techniques (Starkey and others, 1984). Size fractions will be reported as percent by weight of the total sample. About 50 g (grams) of sample is weighed and placed in a beaker with about 200 mL of DI water. The sample will be soaked overnight and disaggregated for 15 to 30 minutes in an ultrasonic generator. The sand-size fraction [greater than 0.062 mm (millimeter)] is collected by wet-sieving with a stainless steel sieve and transferred to an evaporating dish. The sand-size fraction includes all material larger than 0.062 mm. The initial 200 mL of the clay-silt suspension passing through the sieve is collected in a centrifuge bottle and centrifuged at 600 rpm (revolutions per minute) for 7.5 minutes to obtain a clay-size suspension. This suspension is then filtered through a microbore filter where the clay-sized material is collected and transferred to a glass slide for x-ray diffraction analysis. The remaining clay-silt suspension is placed into a 1,000-mL beaker. The clay-silt suspension is centrifuged to separate the silt and clay-size fractions, and each of these are dried and weighed to determine the percentage of each fraction in the bulk sample.

The dried clay and silt-size fractions are then submitted for chemical analysis using ICP-AES (Inductively coupled plasma-atomic emission spectrometry; USEPA method 6010B). Prior to analysis, samples are digested with repeated additions of nitric acid and hydrogen peroxide followed by hydrochloric acid (USEPA method 3050B). This method is not a total digestion technique, but it is a very strong acid digestion that will dissolved almost all elements that could become “environmentally available.”

3.4.1.6 Physical Properties

Specific conductance measurements are made on all water samples (RU bottle) during log in at the USGS laboratories. The specific conductivity meters are calibrated daily using a 2 to 3-point standard curve over the expected operating range of samples generally received. Standards are prepared using potassium chloride. Throughout the day, standard reference water samples of known conductivity are run, and values must be within 1.5 standard deviations to continue. Sample pH also is measured (RU bottle) upon receipt at the laboratory using a combination Ross-type electrode. The pH meter is calibrated daily using commercially prepared buffer solutions (generally 4, 7, and 10) chosen to bracket the expected sample pH values. Calibration of pH meters is checked throughout the day using standard buffers.

3.4.1.7 Nutrients and Anions in Water

Concentrations of nitrate ($NO_3$), nitrite ($NO_2$), and ammonia ($NH_3$) in water samples are determined by colorimetric methods using an autoanalyzer. Concentrations are expressed in mg/L as nitrogen (N). The $NO_3$ is reduced to $NO_2$ using a copper-cadmium column and treated with sulfanilamide under acidic conditions to produce a diazo compound. The diazo compound reacts with n-1-napthylethylenediamine dihydrochloride to form a red compound, which is measured colorimetrically. The $NO_2$ is analyzed directly by treatment with sulfanilamide and n-1-napthylethylenediamine dihydrochloride. Phosphorus and ammonia plus organic nitrogen are measured using colorimetric methods following a Microkjeldahl digestion. Concentrations of $NH_3$ are determined by reacting the sample with sodium salicylate, sodium nitroprusside, and sodium hyperchlorite under alkaline conditions to form a colored compound. Because the reactions are carried out under alkaline conditions, ammonium ($NH_4$ ) in the sample is converted to $NH_3$ and is determined using salicylate-hyperchlolrite.

Concentrations of chloride and sulfate are determined from filtered samples (FU bottle) using ion-exchange chromatography (IC; USEPA method 300.0). Ions are separated based on their affinity for the exchange sites of the resin. The separated anions in their acid form are measured using a conductivity cell. Fluoride is determined from filtered samples (FU bottle) using an ion-specific electrode (ISE).

#### 3.4.1.8 Major and Trace Cations in Water

Concentrations of many dissolved major and trace cations in water (table 4) are determined using the ICP (Inductively Coupled Argon Plasma) method (USEPA method 200.7). The ICP analyses determines all parameters simultaneously by direct-reading emission spectrometry using an ICP as an excitation source. Samples are pumped into a pneumatic nebulizer and atomized and then transported to the plasma torch where excitation occurs. Each analysis is determined on the basis of the average of two replicate exposures, each of which is background corrected by a spectrum shifting technique.

Concentrations of potassium and sodium are determined using AA (Atomic Absorption); concentrations of antimony, arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, silver, and thallium are determined by GFAA (Graphite Furnace Atomic Absorption; USEPA methods 204.2, 206.2, 213.2, 219.2, 220.2, 239.2, 246.2, 249.2, 272.2, and 279.2). In GFAA, the sample is pretreated in a char or ashing step which is designed to minimize the interference effects caused by the sample matrix. The atomization cycle is characterized by rapid heating of the furnace to a temperature where the analyte is atomized from the graphite surface into a stopped gas flow atmosphere of argon containing 5% hydrogen. The resulting atomic cloud absorbs the element specific atomic emission produced by a hollow cathode lamp or an electrodeless discharge lamp. An instrumental background correction is required to subtract from the total signal the component which is nonspecific to the analyte.

### 3.4.2 Method Reporting Levels

The sensitivity of an analytical method is related to the detection level, which is the lowest concentration of an analyte that can be detected at a specific confidence level. The instrument detection level (IDL) is the smallest signal above background noise that an instrument can detect, generally at a 99 percent confidence level. An IDL is measured by analyzing replicate blank samples. The method reporting level (MRL) reported varies depending on the instrumentation, extraction procedure, and analytes of interest, but generally are 3 to 5 times the IDL.

### 3.4.3 Calibration

All equipment and instruments used for quantitative operations and quantitative measurements are controlled by a formal calibration program. Calibration may be periodic or operational. Periodic calibration is performed at prescribed intervals. Operational calibration is routinely performed as part of instrument usage. Whenever possible, recognized procedures such as those published by the ASTM or the USEPA, or procedures provided by manufacturers will be used.

The following discussion describes the general calibration procedures used at the USGS NWQL, QWSU, and contract laboratories. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method. The frequency of calibration and the concentration of calibration standards are determined by the manufacturer's guidelines, the analytical methods, or the requirements of special programs.

Gas chromatography/mass spectrometry (GC/MS) systems—Every 12 hours before analysis of samples, the instrument is tuned with a standard solution of 4-bromofluorobenzene [25 ng/µL (nanograms per microliter) in methanol] for VOCs and decafluorotriphenylphosphine (50 ng/µL in methylene chloride) for SVOCs. An initial calibration curve is produced and certain key compounds are evaluated daily. If the daily standard does not meet the established criteria, the system is recalibrated.

Chromatography systems—Each chromatographic system is calibrated before analysis of samples. Initial calibration consists of determining the linear range, established detection levels, and establishing retention time windows. The calibration is checked daily to ensure that the system remains within specifications. If the daily calibration check does not meet established criteria, the system is recalibrated, and samples analyzed since the last acceptable calibration are reanalyzed.

Inductively Coupled Argon Plasma (ICP) system—Each ICP is calibrated before the analyses are performed. The calibration is then verified using standards from an independent source. The linear range of the instrument is established once every quarter using a linear range verification check standard. No values are reported above the upper concentration value without dilution. A calibration curve is established daily by analyzing a minimum of five standards. The calibration is monitored throughout the day by analyzing a continuing calibration verification standard and blanks. The standard must meet established criteria, or the system is recalibrated and all samples analyzed since the last acceptable calibration check are reanalyzed. Results outside of the established criteria trigger reanalysis of samples.

Atomic Absorption (AA) systems—Each AA spectrometer is calibrated before analyses are conducted. A calibration curve is prepared with a minimum of a calibration blank and six standards, and then verified with a standard that has been prepared from an independent source at a concentration near the middle of the calibration range. The calibration is verified on an ongoing basis with a midpoint calibration standard. If the ongoing calibration standard does not meet established acceptance criteria, the system is recalibrated , and all samples analyzed since the last acceptable calibration check are reanalyzed. All samples are spiked to verify the absence of matrix effects or interferences. The method of standard additions is used when matrix interferences are present.

Other methods—Each system or method is calibrated before analyses are conducted. Calibration consists of defining the linear range by use of a series of standard solutions, establishing detection levels, and identifying potential interferences. The calibration is checked on an ongoing basis to ensure that the system remains within specifications. If the ongoing calibration check does not meet established criteria, the system is recalibrated, and all samples analyzed since the last acceptable calibration check are reanalyzed.

## 3.5 Quality Control Checks for Field and Laboratory Operations

Field and laboratory QC checks are important parts of the QA objectives as defined by PARCC parameters (section 2.2). The QA effort for the New Haven Riverfront RI has been developed to ensure and validate that inconsistencies in field protocols, the field protocols themselves, or analytical protocols do not introduce error into the data-collection process.

### 3.5.1 Field Quality Checks

Field QC checks have been introduced into the sample collection procedures to minimize (and identify if it occurs) the potential for interference or introduction of contaminants during sample collection and processing, storage, transport, and equipment decontamination. Field QC checks include the proper calibration of all field instruments using standard solutions, collection of blank and duplicate samples, and adherence to standard sample collection protocols or documentation of variations. The most common error attributable to field procedures is contamination of the sample matrix. Two general forms of contamination occur: (1) systematic and (2) erratic. The goal of the field QA program is to reduce the systematic component and provide evidence of the erratic component by using the following protocols:

Filtration Blank—Filtration blanks are defined as samples obtained by pumping analyte-free water through the peristaltic pump mechanism and through the capsule filter used for preparing dissolved inorganic constituents for shipment to the laboratory. The filtration blank sample is processed according to the same procedures used for a regular sample and is submitted to the laboratory for analysis. These samples are used to determine the cleanliness of the pump and filter.

Equipment Blank—Equipment blanks are defined as the in-office collection of samples obtained by running analyte-free water through sampling and sample processing equipment into the appropriate sample collection containers. The equipment blank sample is processed and preserved according to the same procedures used for a regular sample and is submitted to the laboratory for analysis. These samples are used to determine the effectiveness of in-office cleaning procedures.

Field Blank—Field blanks are defined as the in-field collection of samples obtained by running analyte-free water through sampling and sample processing equipment into the appropriate sample collection containers. The equipment blank sample is processed and preserved according to the same procedures used for a regular sample and is submitted to the laboratory for analysis. These samples are used to determine the effectiveness of in-field cleaning procedures and to determine if any contaminants are present in the sample collection and processing area that may affect sample integrity. A field blank must be processed for each media (ground water, surface water, soil/sediment) sampled to ensure that each equipment set used in sample collection (for example, pumps, samplers, filtration systems, and sample-compositing equipment) are quality assured. Field blanks and equipment blanks represent about 5 percent of the total number of analyses for the project.

Trip Blank (required only for VOCs)—The purpose of the trip blank is to assess the affect that transporting a sample will have on the representativeness of the analytical results. The trip blank is prepared in the office before the field trip by transferring analyte-free water into the appropriate sample-collection container. These samples are kept with the “real” water-quality samples collected during the sampling trip and shipped to the analyzing laboratory along with “real” samples. The VOC vials have a septum cap that can allow contaminants to enter samples during shipment if contaminant levels are large in the ambient air surrounding the samples. Trip blanks are used to ensure VOC samples are not contaminated during shipment or storage in the laboratory before analysis. Trip blanks are prepared by the NWQL and shipped to the Missouri District. A minimum of one trip blank must be submitted to the laboratory for analysis for all sampling trips. Additional trip blanks will be collected any time field personnel determine a contamination risk is possible.

Replicate Samples—Replicate samples are collected and analyzed to determine the precision of sampling, processing, and field and laboratory analysis. A replicate sample generally is collected immediately after a regular sample (sequential sampling) using the same equipment and sampling techniques. Both the regular and replicate samples are analyzed at the laboratory using identical analytical techniques. A RPD (relative percent difference) greater than 20 percent between the regular sample and replicate would indicate that the sampling process is not representative. Alternatively, a replicate sample is the result of the splitting of a single sample into two complete sets of subsamples. Both the regular and replicate samples are analyzed at the laboratory using identical analytical techniques. A RPD greater than 20 percent between the regular sample and replicate would indicate that the precision of the analytical technique is not acceptable. About 5 percent of the samples analyzed for the project are replicate samples.

Field Spike Samples—The USGS will submit blind field spike samples to the laboratory as provided by the USEPA to measure laboratory accuracy.

Duplicate Field Measurements—Duplicate field measurements are two or more field measurements made under identical conditions. A minimum of one duplicate measurement must be made and recorded for every five field measurements. If possible, the duplicate field measurement should be made by each field person in the field crew that has responsibility for field water-quality analysis.

Field Instrument Calibration—All water-quality field instruments must be calibrated according to the manufacturer’s specifications. Details of field instrument calibration are given in section 3.3.1.

Field Quality-Control Data—USGS personnel are trained in the collection of ground- and surface-water samples, and they participate in the USGS NFQA program. The NFQA program monitors the performance of field project personnel by measuring the accuracy of field pH, specific conductance, and alkalinity measurements. Each field person is annually provided with a known QC check sample for which the upper and lower control limits have been established. These QC samples are tracked by means of a sample ID number and lot number. Frequent review of field collection activities, NFQA program results, and equipment blanks by the project QA officer will be made to ensure the validity of all data collected.

### 3.5.2 Laboratory Quality Checks

The NWQL, QWSU, and USGS contract laboratory are committed to providing high quality environmental-analytical services to the USGS. An extensive QA program has been implemented to ensure analytical data are scientifically sound, legally defensible, and of known and documented quality. Laboratory QC checks are implemented to ensure that laboratory systems (instrumentation , sample preparation, analysis, data reduction, etc.) are operating within acceptable QC guidelines and to minimize or document the occurrence of laboratory contamination and variability in analytical results.

Quality checks in the laboratory include internal QC checks at the bench scale (blanks, matrix spikes, matrix spike duplicates, surrogate spikes, and duplicates) and internal blind samples, automated computer checks [ion balance, specific conductance/dissolved ion ratios, alert limits for constituents above USEPA MCLs (Maximum Contaminant Levles)], and external checks (external performance evaluation studies and external audits). A detailed description of laboratory QA and QC protocols is given in Friedman and Erdmann (1982).

#### 3.5.2.1 USGS Branch of Quality Systems

The function of the Branch of Quality Systems (BQS) is to monitor, assure, and improve the quality of analytical results for the USGS. The BQS, which is independent of the NWQL, QWSU, and USGS contract laboratory, administers programs that document analytical methods used for inorganic, organic, and biological constituents by the NWQL, QWSU, and other non-USGS laboratories.

Standard Reference Sample program—The Standard Reference Sample (SRS) program conducts an interlaboratory evaluation program semiannually. The SRS provides a variety of inorganic SRSs to accomplish quality-assurance testing of laboratories and also provides inorganic reference materials for in-house quality-control programs.that (Janzer, 1985). Natural-matrix inorganic reference materials are preferred for use in this interlaboratory evaluation program. Though this is not a laboratory certification program, participation in this continuing quality-assurance program is mandatory for all laboratories providing inorganic water analyses data for USGS data storage or use.

Organic Blind Sample Project—The BQS submits samples of known chemical composition to the Organic Chemistry Program at the NWQL to evaluate analytical methods used at the laboratory. These samples, which include blanks and spikes, are termed “blind” because the sample origin and chemical constituents are unknown to the analyst. Results of the blind samples reflect the actual performance of the laboratory processes because the blind samples are treated the same as environmental samples. The assessments identify not only the baseline performance capabilities of the methods in the Organic Chemistry Program at the NWQL but also identify strengths and weaknesses in the current system of bench-level quality and process control. Generally, the Organic Blind Sample Project (OBSP) submits samples at a rate of 3 to 5 % of the environmental samples analyzed at the NWQL during the previous year.

Inorganic Blind Sample Project—The Inorganic Blind Sample Project (IBSP) is an independent, external, quality-assurance project to monitor and evaluate the quality of laboratory analytical results through the use of blind QC samples. These samples are submitted to the NWQL and the QWSU. The information provided assists the laboratories in detecting and correcting problems in the analytical procedures.

3.5.2.2 National-Water Quality Laboratory

The QA/QC procedures used by the NWQL are described in Pritt and Raese (1995). The Quality Management Program (QMP) oversees the QA functions for the NWQL through the Quality Assurance Unit (QAU). The QAU carries out operations related to monitoring and improving the quality of NWQL analytical programs through audits, data reviews, customer support and communications, and training. The QAU does twice per month analytical line audits, develops SOPs (Standard Operating Procedures), and reviews the SOPs against the procedures being used. Additionally, the QAU coordinates and maintains the NWQL certifications for various Federal and State environmental regulators who participate in Federal-State Cooperative program.

The NWQL participates in the BQS SRS, OBSP, and IBSP. In addition, the QMP conducts an internal blind sample program within the NWQL to monitor the performance of the inorganic and organic programs. The blind samples include laboratory replicates, matrix spikes, method blanks, and reagent blanks. Blind samples usually are returned to the QMP within 24 hours to allow the QMP to respond with corrective action reports to the appropriate sections if a result is outside an acceptable range (generally 1.5 standard deviations of external blind sample results). The NWQL also participates in a number of external performance evaluation studies, including (1) U.S. Environmental Protection Agency Water-Supply (WS) study, (2) U.S. Environmental Protection Agency Water-Pollution (WP) study, (3) Canadian Center for Inland Water Samples, and (4) National Oceanic and Atmospheric Administration.

Eternal agencies audit the NWQL to assess the analytical and quality programs. The BQS annually reviews the NWQL. The Colorado Department of Public Health and Environment triennially audits NWQL analytical QA activities that correspond to the USEPA's Drinking-Water Regulations. The New York State Department of Health audits the NWQL for the National Environmental Laboratory Accreditation program.

3.5.2.3 Quality Water Services Unit

The QA/QC procedures used by the QWSU are described in the Comprehensive Quality Assurance Plan (1999). The QA officer oversees the QA functions for the QWSU, which are similar to those performed at the NWQL. QWSU participates in the BQS SRS and IBSP and is reviewed every 2 years by the BQS. In addition, the QA officer conducts an internal double blind QA program, which consists of weekly submission of check samples to analysts. These check samples consist of mocked-up SRS samples, laboratory replicates, matrix spikes, method blanks, and reagent blanks.

3.5.2.4 U.S. Geological Survey Contract Laboratory

The QA/QC procedures used by the USGS Contract Laboratory in Denver, Colorado (currently known as Severn-Trent Laboratories; formerly known as Quanterra) are described in their Quality-Assurance Management Plan (1998). A USGS Contracting Office Representative [Office of Ground Water, DODEC program (U.S. Department of Defense Environmental Contamination Program)] oversees the laboratory from both a contractual and QA standpoint. All data from the USGS contract laboratory are reviewed by the Contracting Office Representative and QA problems are noted in a separate report. The contract laboratory has been certified for use by the USGS (reviewed by BQS), the U.S. Army Corps of Engineers, and multiple states. The contract laboratory participates in numerous external performance evaluation studies, including the USGS SRS, OBSP, and IBSP programs and the USEPA WS and WP programs.

# 4.0 DATA MANAGEMENT

The overall project data management will follow the steps listed in table 6. The person or laboratory responsible for each step also are listed. The Project Chief will delegate authority and responsibility for satisfactory completion of the data management steps.

Table 6. Data management procedures and responsibilities.
[QA, quality assurance; COC, chain-of-custody; NWIS, National Water Information System; LIMS, Laboratory Information Management System; RI, Remedial Investigation]

| Item | Data management step | Responsible party | Reviewer |
|---|---|---|---|
| 1 | Daily field notebook entries | Collector | Project QA Officer |
| 2 | Enter field data and sample collection information on field notes form | Collector | Project QA Officer |
| 3 | Completion of COC form | Collector | Project QA Officer |
| 4 | Daily QA on-site review of field notebooks, measurements, field notes forms, COC forms | Field team | Project QA Officer |
| 5 | Sample processing and shipment | Collector | Project QA Officer |
| 6 | Enter field data into NWIS or alternative data base | Collector | Project QA Officer |
| 7 | Laboratory analyses and raw data entry into LIMS | Analyst | Laboratory QA personnel |
| 8 | Laboratory reports of results and QA/QC data | Laboratory | Project QA Officer |
| 9 | Data processing | Project QA Officer | Project Chief |
| 10 | Data check and validation | Project QA Officer | Project Chief |
| 11 | Data collection progress review | Project Chief | Project QA Officer |
| 12 | Data incorporation into progress reports and final RI document | Project Chief | Project QA Officer |

### 4.1 Data Reduction and Verification

Review of laboratory data and verification are performed by a qualified laboratory analyst at the USGS NWQL, QWSU, or contract laboratory prior to being released electronically to the individual USGS district offices. Field personnel are responsible for converting all raw values produced in the field into reportable values. The records of all data reduction calculations must be kept on the water-quality field notes forms or field notebook. Field personnel are responsible for entering their field data onto the water-quality field notes form or field notebook and into the Missouri District NWIS or alternative data base system under the supervision of the Project QA Officer. All data are verified by printing a hard copy of all field information entered (for example, water level, discharge, and field water-quality constituents) and comparing against raw data values contained on the water-quality field notes form.

The laboratory analyst is responsible for converting all raw values produced in the laboratory into reportable values. The records of all data reduction calculations must be kept on the appropriate laboratory worksheet. If the final values are not generated by direct-reading instruments or if a computer analyst performs all necessary data reduction of the raw data, the laboratory analyst is responsible for recording the final values on computer-generated laboratory worksheets. All strip charts and chromatograms must be labeled, dated, and initialed by the analyst performing the analysis. Each laboratory worksheet bears a unique run-ID number. This run-ID number is part of a multiple index system used by the LIMS to identify the samples and constituents performed for an individual worksheet. The analyst also is responsible for verifying that reagent spikes, blanks, check standards, and duplicates are within acceptable limits. If all QC samples are within acceptable limits, the analyst will submit the worksheets to the Automatic Data Processing (ADP) unit where they are checked against the log in request sheets, and the values are entered into the computer system. The ADP unit also scans the raw data and looks for anomalies before entering the data into the LIMS. The LIMS store the data until all requested analyses are complete; the data are then transferred to the USGS NWIS. The NWIS software performs a number of automatic verification checks before the data are released for electronic transfer to the Missouri District office. On receipt in the District, all the data are printed and checked for anomalies by the Project QA Officer. The Project Chief and Project QA Officer will review the laboratory data and check for the proper entry of sample data and field measurements.

All injections (standards, blanks, and samples) made on the portable GC are stored in digital form on a memory card. The injections are identified by type (standard, blank, sample, duplicate, etc.), matrix (soil, water, QC, etc.), sample name, date, time, injection volume, and analysis number (sequential number assigned daily by the GC). At the conclusion of each day, data will be transferred from the GC to a personal computer for backup, and a hard copy of each analysis will be printed.

### 4.2 Data Documentation

The USGS maintains complete documentation on field activities, sample collection, sample handling, and laboratory analysis. All field notes, notebooks, calibration records, water-quality field note forms, and discharge measurement forms are considered original data and are retained in a permanent project file in the Missouri District office. Shipping receipts, copies of the ASR forms, and COC forms also are archived in the District office. Notes included on the ASR forms to the laboratory are entered into the LIMS at sample log in and are available to bench chemists, supervisors, and laboratory QA personnel. Laboratory worksheets containing all pertinent information regarding analytical conditions during each sampling run, including dilutions, matrix problems, and interferences, are archived at the laboratory. Comments from bench chemists are entered into the LIMS and are supplied electronically to the collector with the completed analytical data through the NWIS.

The Missouri District NWIS system permanently stores water information for Missouri. The system is made up of three linked data bases: water quality (QWDATA), ground water [Ground-Water Site Inventory (GWSI)], and surface water (ADAPS). Each field site for the project is assigned a unique 15-digit number, which includes the latitude and longitude of the site plus a 2-digit sequence number. All data are associated with unique 5-digit parameter codes that make it possible to retrieve certain types of data. Several thousand parameter codes are available, including sample collection descriptors, well information descriptors, and a variety of inorganic and organic constituent descriptors. Analytical data not entered into the LIMS or NWIS systems, such as values for constituents that do not have appropriate parameter codes or values that were obtained using non-approved methods (screening methods, such as the portable GC), are entered into a project water-quality data base on a personal computer. The Project Chief and Project QA Officer will summarize all analytical data (including screening data) in a table format on the Missouri District homepage at http://wwwdmorll.er.usgs.gov/.

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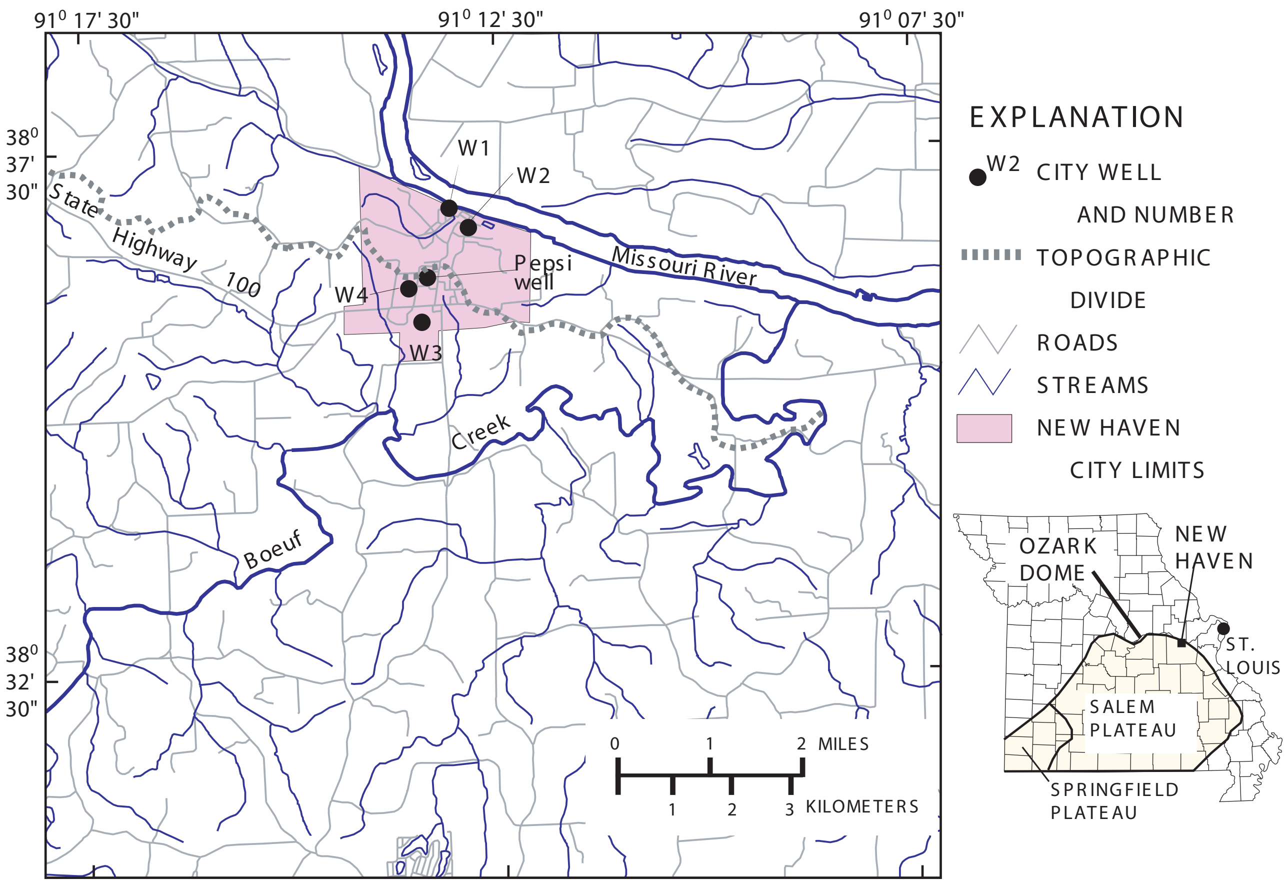


Figure 1. Location of New Haven, Missouri.

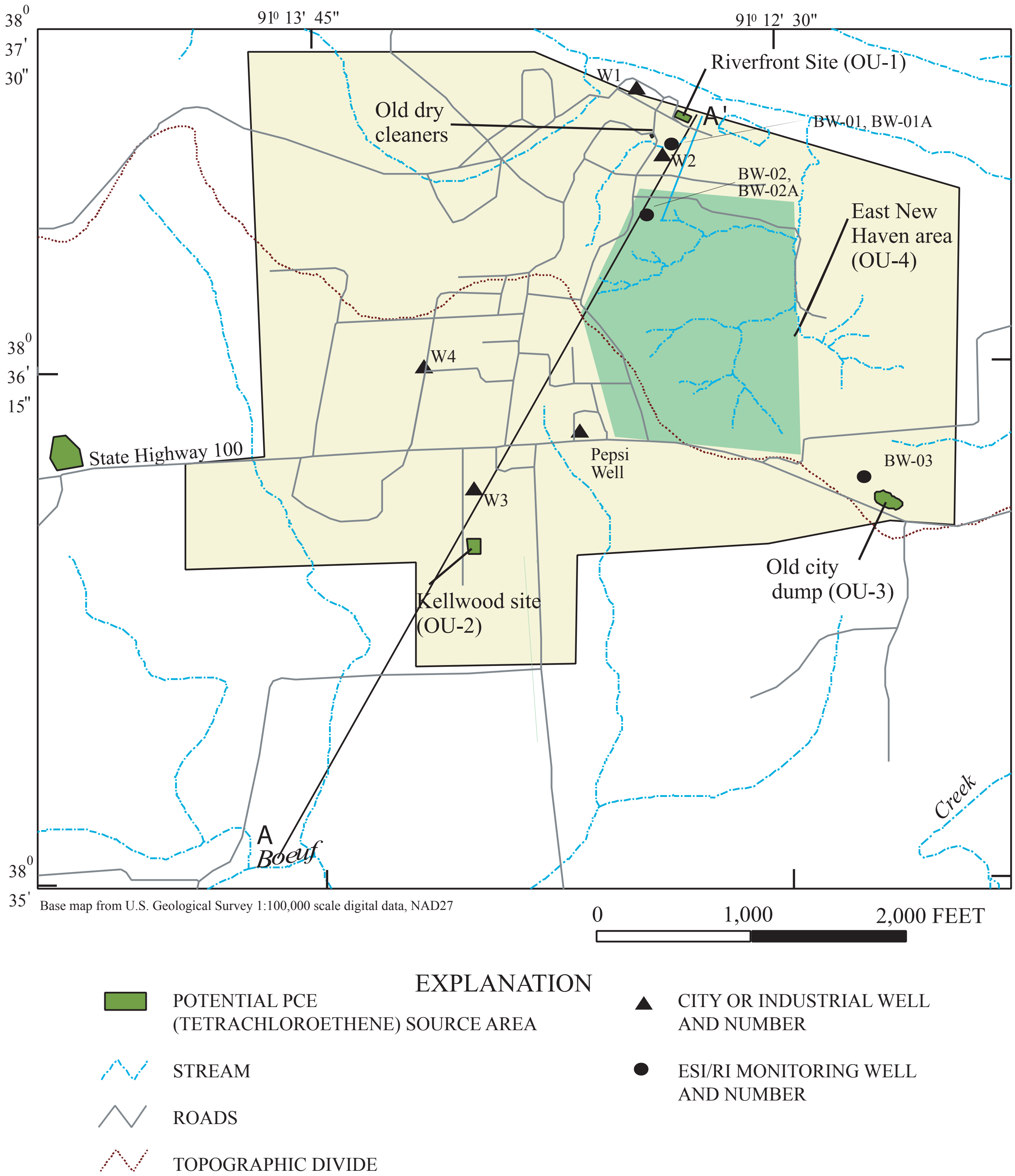


**Figure 2.** Location of potential PCE (tetrachloroethene) source areas in New Haven identified by the Missouri Department of Natural Resources and the U.S. Environmental Protection Agency and proposed OUs (operable units) for the remedial investigation..

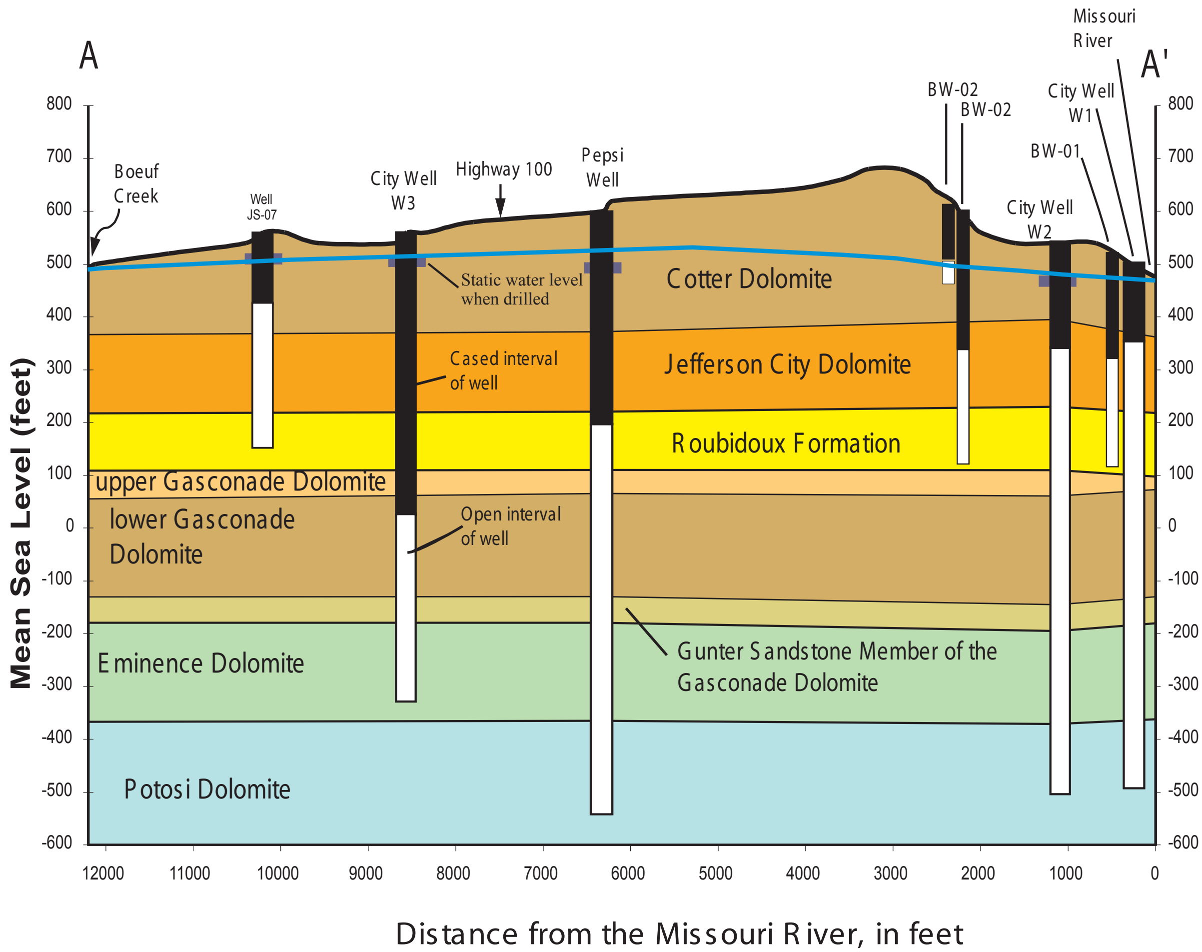


Figure 3. Generalized geohydrologic section A-A' in the new Haven Area. (location of the section is on figure 2).

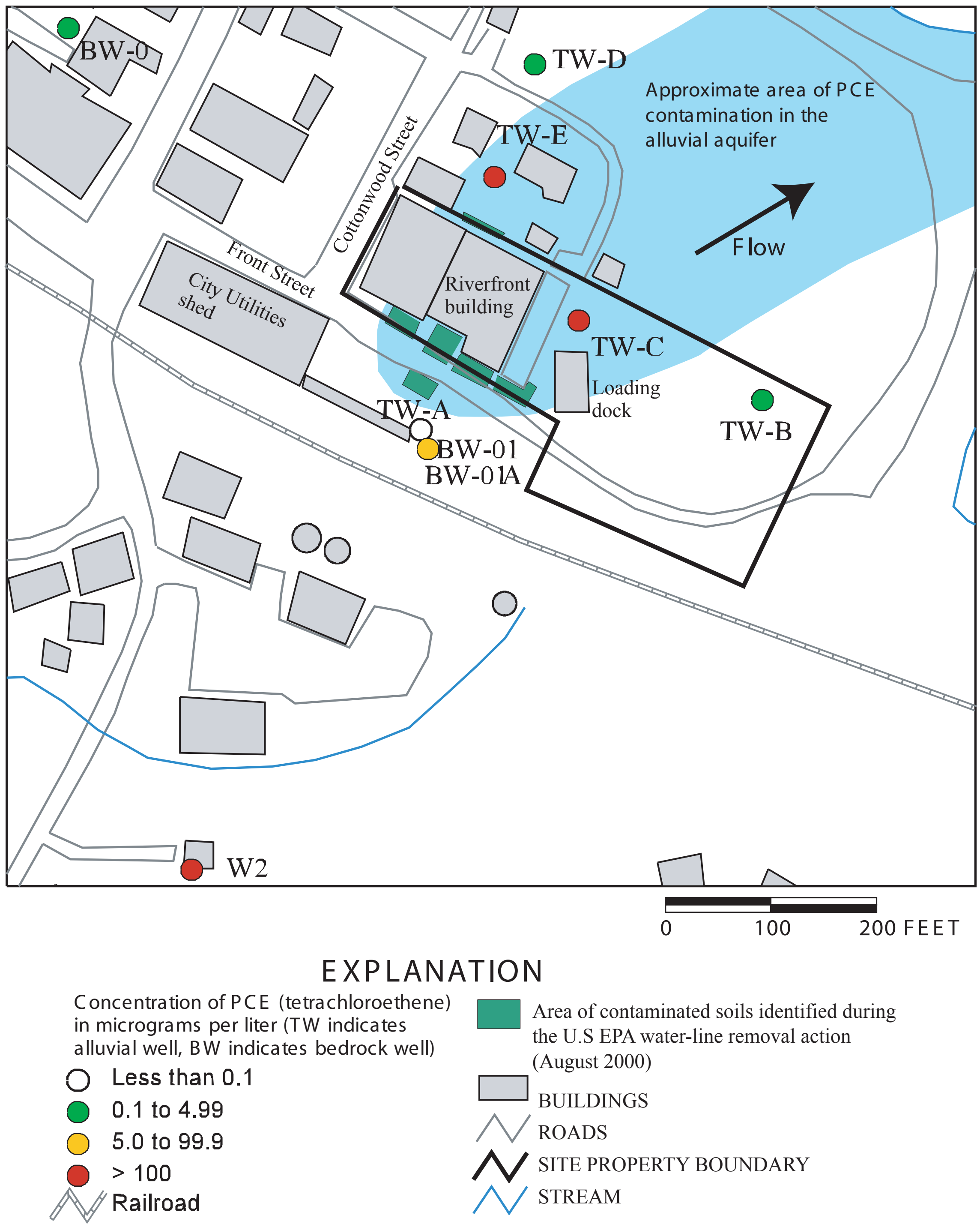


Figure 4. Concentrations of PCE (tetrachloroethene) detected in alluvial and bedrock wells in the vicinity of the Riverfront site.

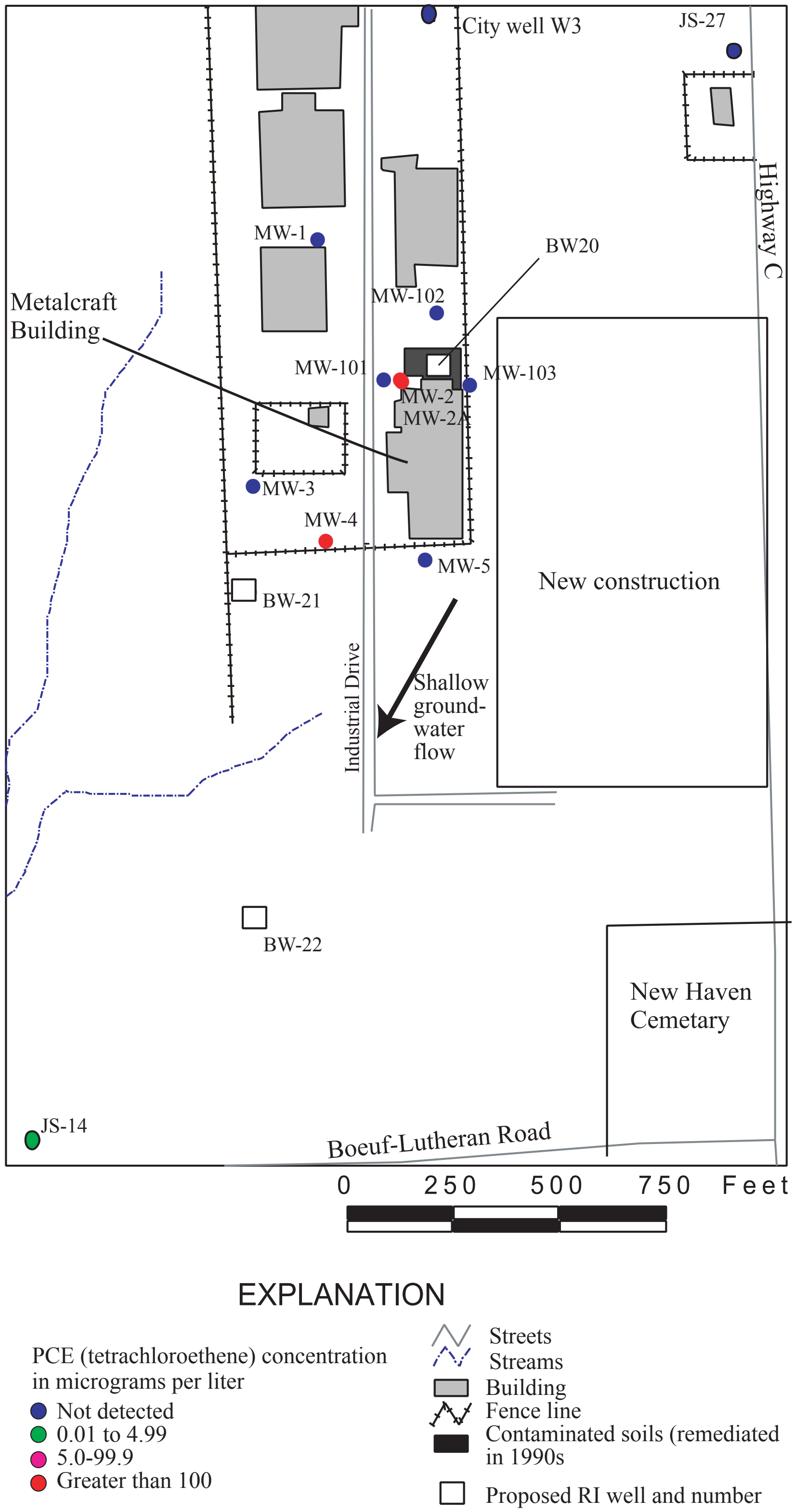


Figure 5. Features of the Kellwood/Metalcraft site (OU-2) and location of proposed monitoring wells.

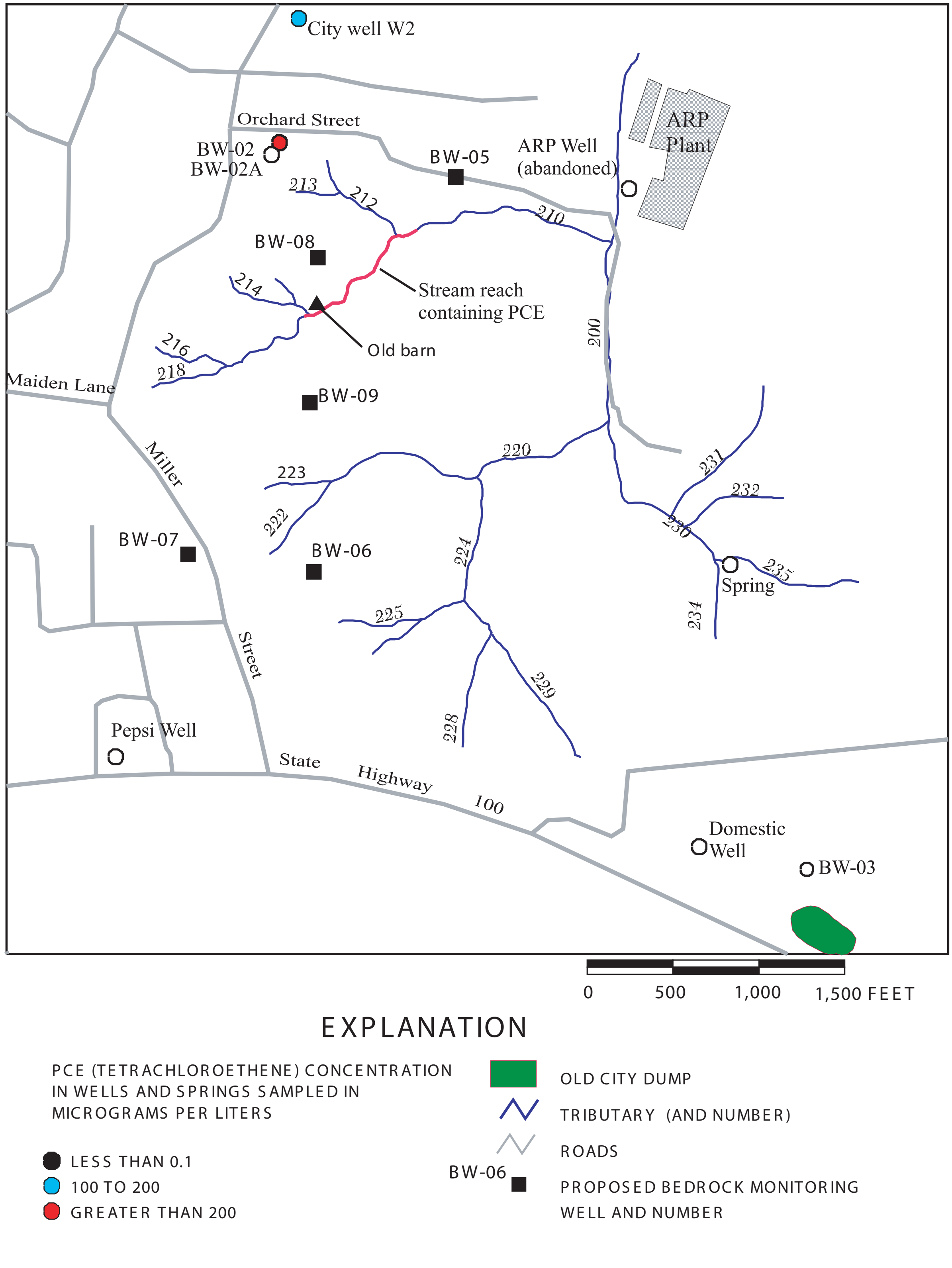


Figure 6. Concentrations of PCE (tetrachloroethene) in samples from wells, springs, and streams in the area south and east of city well W2.